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There have been other electrical experimental outfits on the market thus far, but we do not believe that there has ever been produced anything that comes anywhere near approaching the new experimental outfit which we illustrate herewith.

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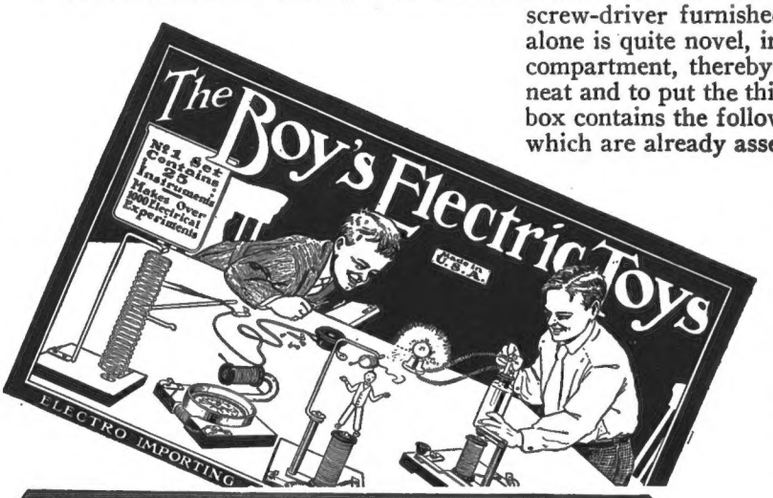

No. EX2002

Student's chromic plunge battery, compass-galvanometer, solenoid, telephone receiver, electric lamp. Enough various parts, wire, etc., are furnished to make the following apparatus:

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The box alone is a masterpiece of work on account of its various ingenious compartments, wherein every piece of apparatus fits.

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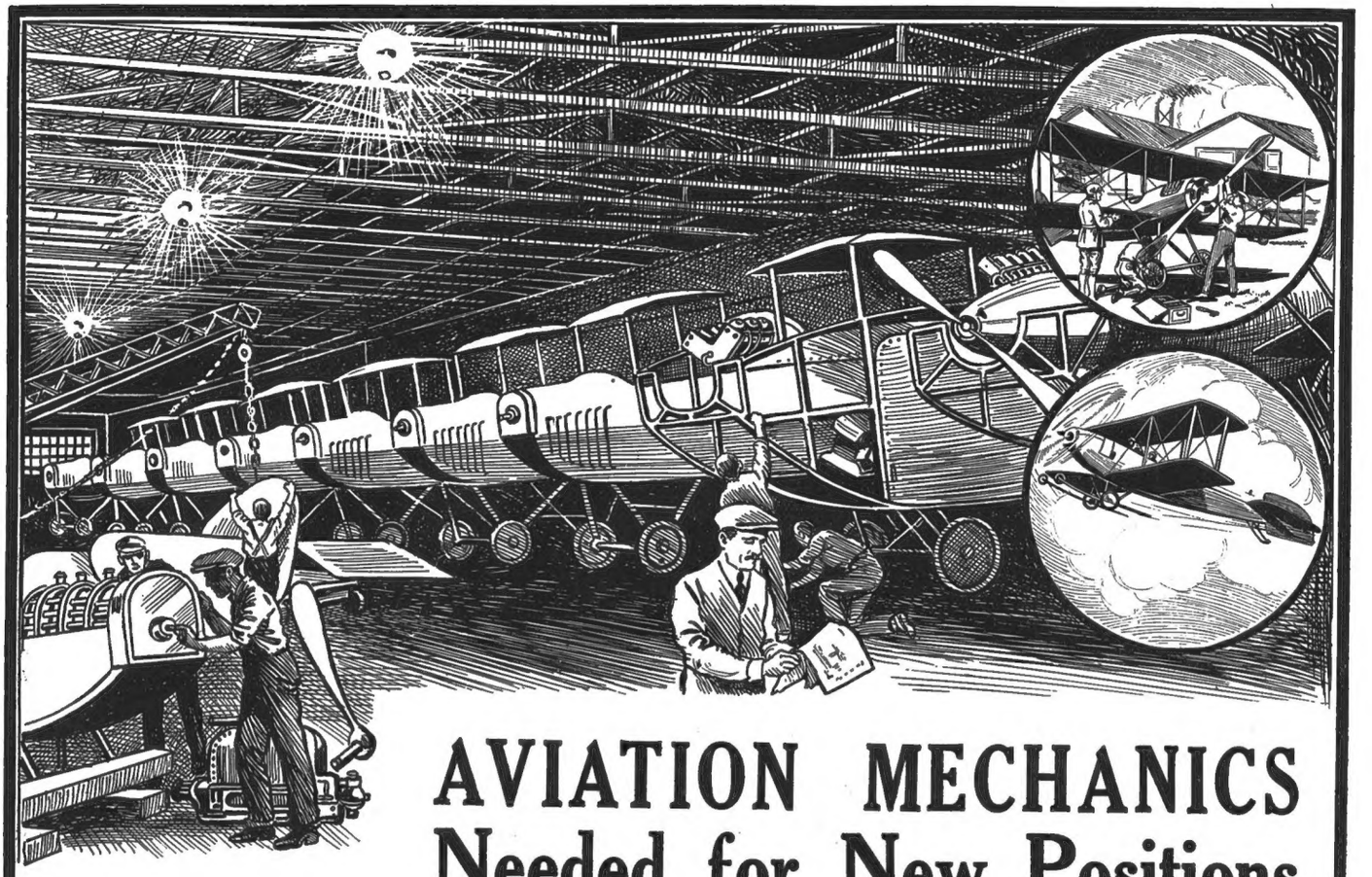

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Gravitation and Electricity

IN our issue of October, 1916, we mentioned editorially that gravitation was an electromagnetic phenomenon. We also ventured the opinion that what we know as gravitation—like light—probably was only still another manifestation of that mysterious thing we call ether. We furthermore advanced the term of "gravitational waves," to better express our thoughts, because we felt that if gravitation was an electromagnetic phenomenon, it was probably due to a distinct wave motion in the ether.

Up to the time of our writing there did not exist experimental proof that gravitation really was an electromagnetic manifestation of the ether; the ideas in our editorial merely being the rather plausible theories of our leading scientists. To the layman the idea of gravitation being an electric phenomenon came somewhat as a surprise; nor were there many adherents to the new theory. For, the reasoning was, what electrical force could possibly draw a stone earthward, when released by the hand? But at last experimental proof has been forthcoming thru the untiring labors of our brilliant Professor Francis E. Nipher, of the St. Louis Academy of Science. In a pamphlet issued November 8th, 1917, Professor Nipher supplies experimental evidence that gravitational attraction can not only be suspended or nullified by the electrical current, but it actually can be transformed into "gravitational repulsion!"

All during the summer of 1917, Professor Nipher has had his apparatus in almost continuous operation and the experiments have been repeated time and again, always with the same result. To understand better what follows, let us keep in mind the fact that all masses attract each other gravitationally. Thus, for instance, if we suspend a stone by means of a string at sea level, the only mass that will attract the stone will be the earth. In this case the stone will hang absolutely vertical, *i.e.*, at right angles to the earth. But take the same stone with its string and carry it up a mountain, let us say half way up, then the earth, too, will still attract the stone. But so will the large mass of the mountain, with the result that the string will not hang absolutely at right angles to the level of the earth, but the stone will be pulled *slightly towards the mountain*, because of the attracting mass of the mountain.

Professor Nipher's apparatus briefly consists of two large lead spheres ten inches in diameter, resting upon heavy sheets of hard rubber. Two small lead balls, each one inch in diameter were now suspended from two silk threads, stationed at the sides of the two large lead spheres, from which they were separated a little distance. Moreover, the suspended balls were insulated elaborately from the large spheres by enclosing them first airtight in a long wooden box, which was also covered with tinned iron sheets as well as cardboard sheets. There was furthermore a metal shield between the box and the large metal spheres. The large metal lead spheres now exerted a certain gravitational pull upon the suspended small lead balls, just as the mountain attracted our stone as mentioned before. The silk suspension threads therefore did not form a "plumb-line" but the small lead balls were slightly pulled over towards the large spheres.

Now, Professor Nipher applied an electrical current to the large spheres—20 amperes alternating current. The gravitational attraction was quickly reduced to zero, and not only that but in 15 to 20 minutes the small lead spheres *had moved away over one-half as much to the opposite direction* as the distance they had been attracted originally towards the large masses. Thus gravitation had not only been completely nullified, but it was *actually reversed.*

This is equivalent to our stone rushing skyward when released, instead of falling to the earth!

Prof. Nipher's historic experiment is certainly one of the most important discoveries of the century. When it leaves the laboratory, as it surely shall—it will not only revolutionize the world, but it will make man free from his gravitational fetters that now chain him to the earth like a rock.

H. GERNSBACK.

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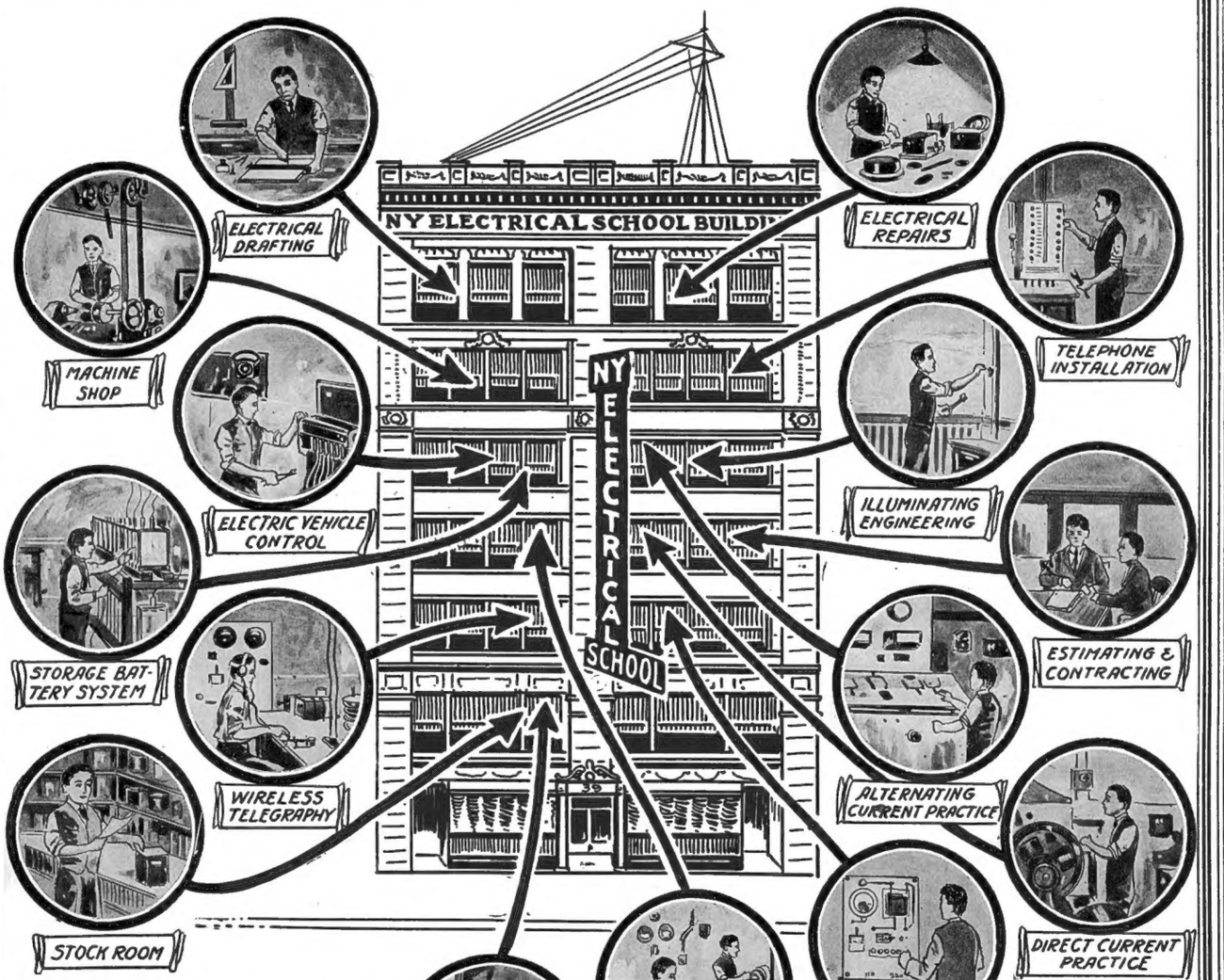

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ELECTRICAL EXPERIMENTER

H. GERNSBACK EDITOR
H. W. SECOR ASSOCIATE EDITOR

Vol. V. Whole No. 58 | February, 1918 | Number 10

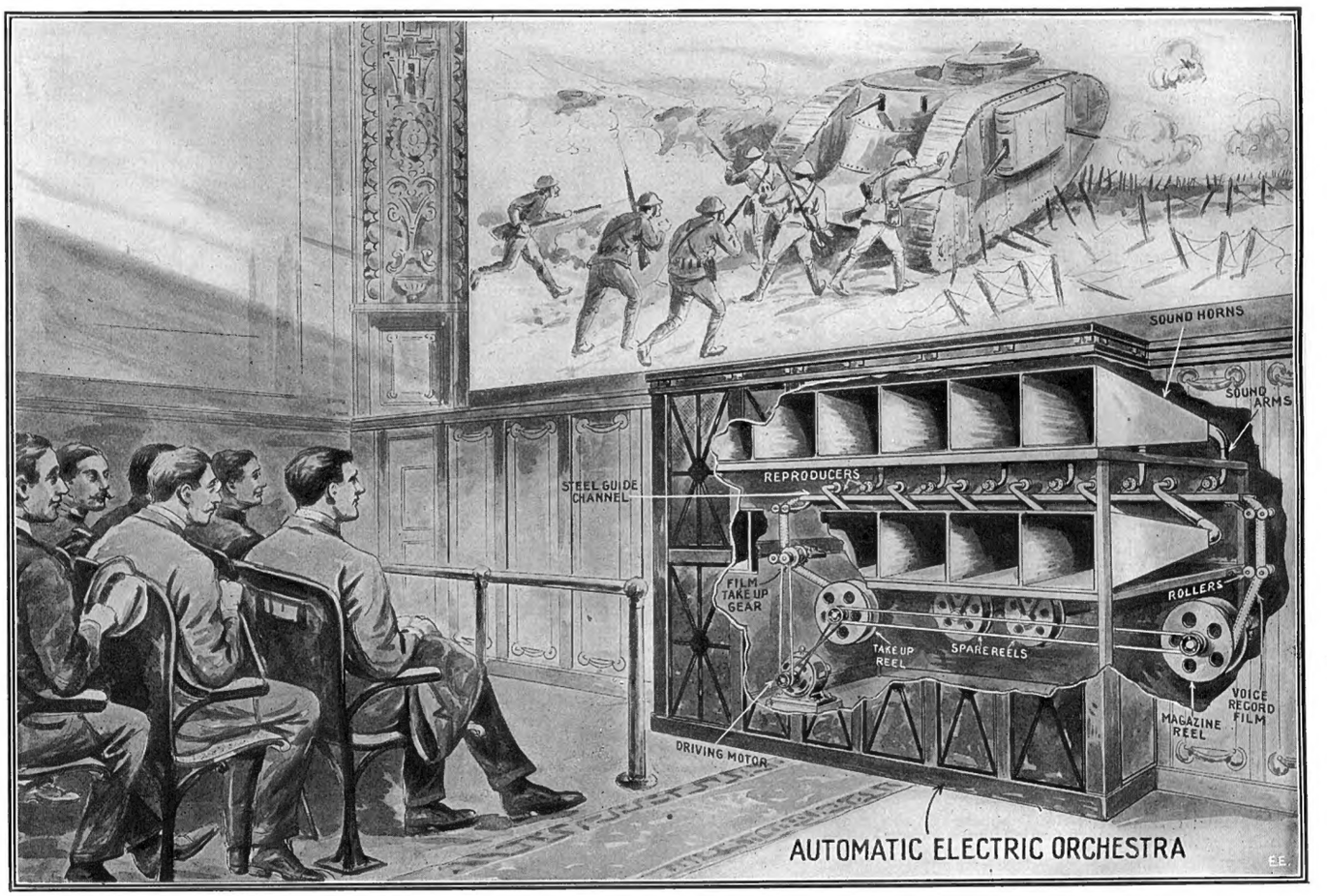
New Orchestra Phonograph Plays 48 Records at Once

WHILE the phonograph or gramophone has been perfected lately to a very high degree, there nevertheless still remained the fact that all sound waves of various lengths had to be produced at the same time with a single diafram or soundbox.

Assume that the sounds produced at exactly the same moment by a violin and a violincello or contrabasso shall be reproduced by one diafram respectively and thru the vibration of one needle transmitted to said diafram. How is it possible? The note of the violin sound may be much higher than the note of the 'cello, with a variation in the length of both sound waves so great as to require a very different vibration of the diafram to produce those two particular sounds properly and *actually at the same moment.* To do this would be just as impossible for the diafram as it would for a pendulum to swing to the right and left at precisely the same moment, or for an elevator to move up and down its shaft at the same time.

It is, therefore, obvious that these two different sounds must have been produced at different times successively, notwithstanding that we *seem* to hear them to a certain extent distinctly and apparently at the *same time.* The fractions of time between both sounds are so short that we cannot distinguish between them, just as we see in a moving picture apparently only one continuous picture and are unable to distinguish between the many thousands of single pictures which pass actually before our eyes.

This fact also explains why we find that

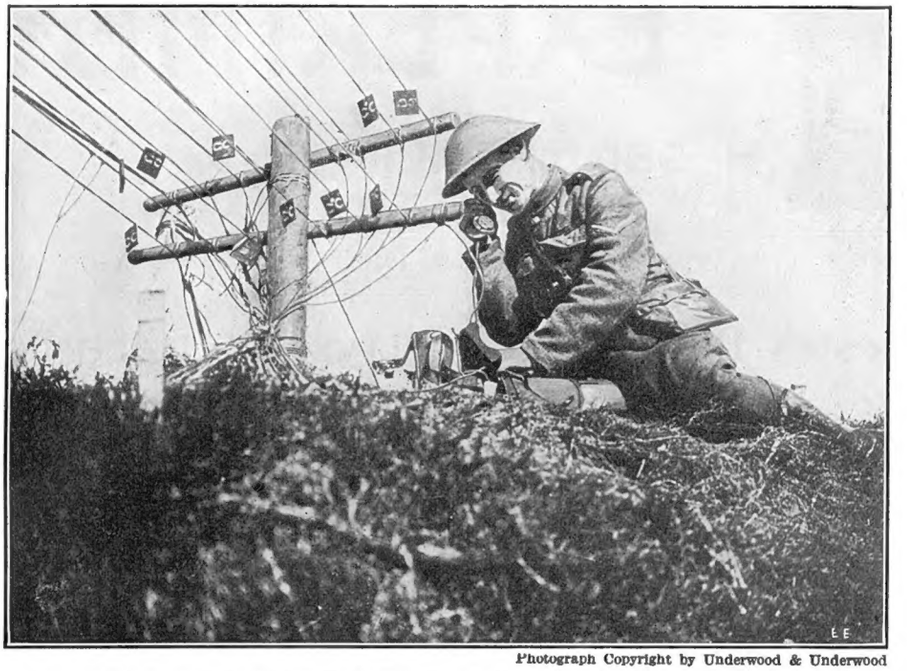


Theatre Managers Have Often Tried a Phonograph In Place of an Orchestra, But the Volume of Sound Proved Insufficient. The Latest Is the "Orchestra Phonograph," Which Records Each Instrument or Voice Separately and Reproduces Them All Together in Perfect Harmony. The Records Are Made on a Special Film. It Represents Science Applied to the Phonograph, for It is Manifestly Impossible for a Single Record to Record and Reproduce Faithfully More Than a Few Voices or Instruments.

Testing The "Ears of The Army"

The accompanying photo shows a British "Tommie" of the signal service testing an army telephone line near the battle front. The little poles shown in this British official photograph are used to keep the wires high enough from the ground to avoid grounding while at the same time they are low enough to prevent their being seen by the enemy.

The telephone lineman in this war is as much of a hero as the man in the trenches. He must often go out to repair broken circuits when that particular line is under shell fire. The "ears of the army" must not fail—not even for an instant. Every break in a circuit must be repaired as soon as possible, and that usually means a few minutes after a shell was hit. One thing is certain—the Signal Corps men are rendering wonderfully efficient service in this war.



Photograph Copyright by Underwood & Underwood

A British "Tommy" Repairing Telephone Lines Near the Battle-Front. Note the Short Poles in Use.

GET OUT THE INK! WRITE TO THE SOLDIERS AND SAILORS.

"Tell the boys who are still on your side of the water that if they know a single lad who is over here, doing his bit either afloat or ashore, for God's sake write to him."

This is an extract, unabridged, from a letter which came to one of us this week from faraway Egypt, says a writer in *The Oscillator*, the magazine publisht by the U. S. Naval Radio School at Harvard University. It is from an officer in command of an American vessel, and his complaint is, that aside from the human sympathy it engenders, the lack of friendly letters from the home side of the sea is a serious detriment to the morale of his crew.

"Only one of my men hears regularly from his friends," he says. "Mail does not reach us often. About once a month a batch arrives, and if you or any of the boys could see the blank dismay, the bitter expressions of homesickness that cannot be kept down when I have to say 'No mail for you this time, Jack, you'd sit right down and write a long, newsy, chatty letter to every man you know who's over on this side, three thousand miles from any American town."

It'll take up only a little bit of our time; let's every one of us shoot along the good word to every man we know over there. And there is not one of us but who has at least one friend in or alongside the Big Fight.

A new dining room table is equipt with electric plate warmers, built in the table.

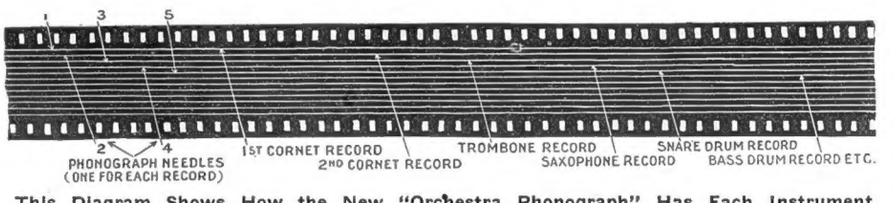
---

the reproduction of a *single* voice or a single instrument, for instance a violin solo, is so much more distinct and why we obtain better effects than if we listen to a record reproducing at apparently the same time *several* voices or instruments. We also can understand the words of a single person spoken at a time from a record much better than if we hear several voices together, because the reproducing vibrations of the diafram are curtailed by the different vibrations required for the reproduction of different voices or instruments, as in most cases the diafram has to make a sort of a compromise between the different vibrations produced at a certain moment, and has to adjust itself accordingly to a certain vibration which actually does not represent the proper sound of any of the various sounds at that moment, but which seems to our ears to give the composite effect of all of them.

While we reproduce with a wonderful perfection a single voice or a single instrument with the gramophone, the effect obtained never equals the original when it comes to reproducing an orchestra of musicians or a chorus of singers.

Therefore, many persons and phonograph manufacturers have attempted during the past several years to perfect an instrument wherein several diaframs, needles and sound records are used at the same time, but the difficulty of obtaining a perfect synchronism proved unsurmountable. If the different diaframs are not actuated in absolute synchronism, the discordant effect can easily be imagined. It would amount to the same as if the various singers of a chorus or the musicians of an orchestra would not act in perfect harmony.

The difficult problem of reproducing different voices or musical instruments with a phonograph or gramophone at the same time with as many different, independent diaframs and sound records in absolute perfect synchronism and harmony has now been solved in a surprisingly simple manner by Mr. H. Hartman, an electrical engineer of New York City, who has applied for patents on his invention in practically all the larger countries. In a personal interview at his laboratory the inventor gave the author interesting details regarding his novel, wonderful invention which probably will revolutionize the phonograph and secure to the same a dominating place in many places of recreation, especially in moving picture theatres, large restaurants, music halls, etc., where this new *"electric orchestra"* will play without interruption for hours the best works of our great masters of music in a manner difficult to distinguish from the original music which has been thereby recorded. It will probably also soon be found in many homes thruout the world, especially in country places, as it can reproduce whole operas and a whole chorus of singers in perfect synchronism.



This Diagram Shows How the New "Orchestra Phonograph" Has Each Instrument Recorded On a Special Film. A Separate Needle Rests in Each of the 48 Sound Record Lines and All of Them Thus Reproduce In Syntony and Harmony.

We have already described various other inventions of Mr. Hartman in previous numbers of the ELECTRICAL EXPERIMENTER, and also his "SPEAKING CLOCK" in our February, 1917, issue, which tells the time every quarter of an hour. In this speaking clock Mr. Hartman uses a *flexible celluloid film* in place of a solid disk or cylinder as the carrier of the sound records, and out of this basic idea he has developed his present *Multiple Diafram Phonograph* or "Electrical Orchestra." While he uses a film less than two inches wide in his above mentioned speaking clock, having forty-eight different sound record lines, parallel to each other, the present invention is also based upon the use of a film as sound carrier with as many independent sound record lines on the same as there are diaframs in his instrument. The number of these is practically unlimited. The film, which moves with about half the speed of that in a motion picture projector, is wound upon a reel and inserted into a lower compartment from where the film is led over guide rollers to a long, narrow and horizontally arranged compartment which contains as many sound-boxes (diaframs) as there are record lines on the film. In designing this remarkable machine care has to be exercised, of course, to isolate each sound box as much as possible, so as to prevent confusion of the sounds in the sound-box compartment. All diaframs are in a horizontal line and resting with their own weight freely upon the film which passes thru a small channel rail and then over a second series of guide roll-

(*Continued on page* 732)

Why Not Aerial "Stepping Stones" from U. S. to Europe?

By F. S. WINGER

Each "stepping stone" a gigantic floating fortress, and the distance between each one 200 miles let us say. A constant stream of aeroplanes could thus fly from the United States to Europe—20,000 of them in one year—predicts the author of this interesting article. Radio messages could be relayed from one "stepping stone" to another with much less chance of interference and interception as at present.

It is admittedly impossible at present to attempt flying the entire aerial fleet of Uncle Sam across the ocean, however much it might expedite the delivery of the promised 20,000 aeroplanes to our Allies. Here's a unique and feasible plan—feasible at least under this war's conditions, with Germany's battle-fleet bottled up—which is proposed by a Chicago genius and author—Mr. F. S. Winger, who originally conceived this idea and described it in his book, "The Wizard of the Island," altho in that work the idea has not a military dress. The present article prepared for the ELECTRICAL EXPERIMENTER *by Mr. Winger, describes his latest ideas in this direction.*

* * * * * *

MAKE each "Stepping Stone" a huge float—each float a veritable floating fortress, defensively armed and equipt to meet any emergency which the enemy could menace them with, which under the conditions of their bottled-up-Navy would probably be limited to their submarines.

Each float to carry a supply of stores, maintain a repair department, etc., and to have just sufficient mobility to enable it to successfully oppose any drifting tendency on the part of either ocean or air currents, so that they could maintain a fixt latitude and longitude—their chief purpose.

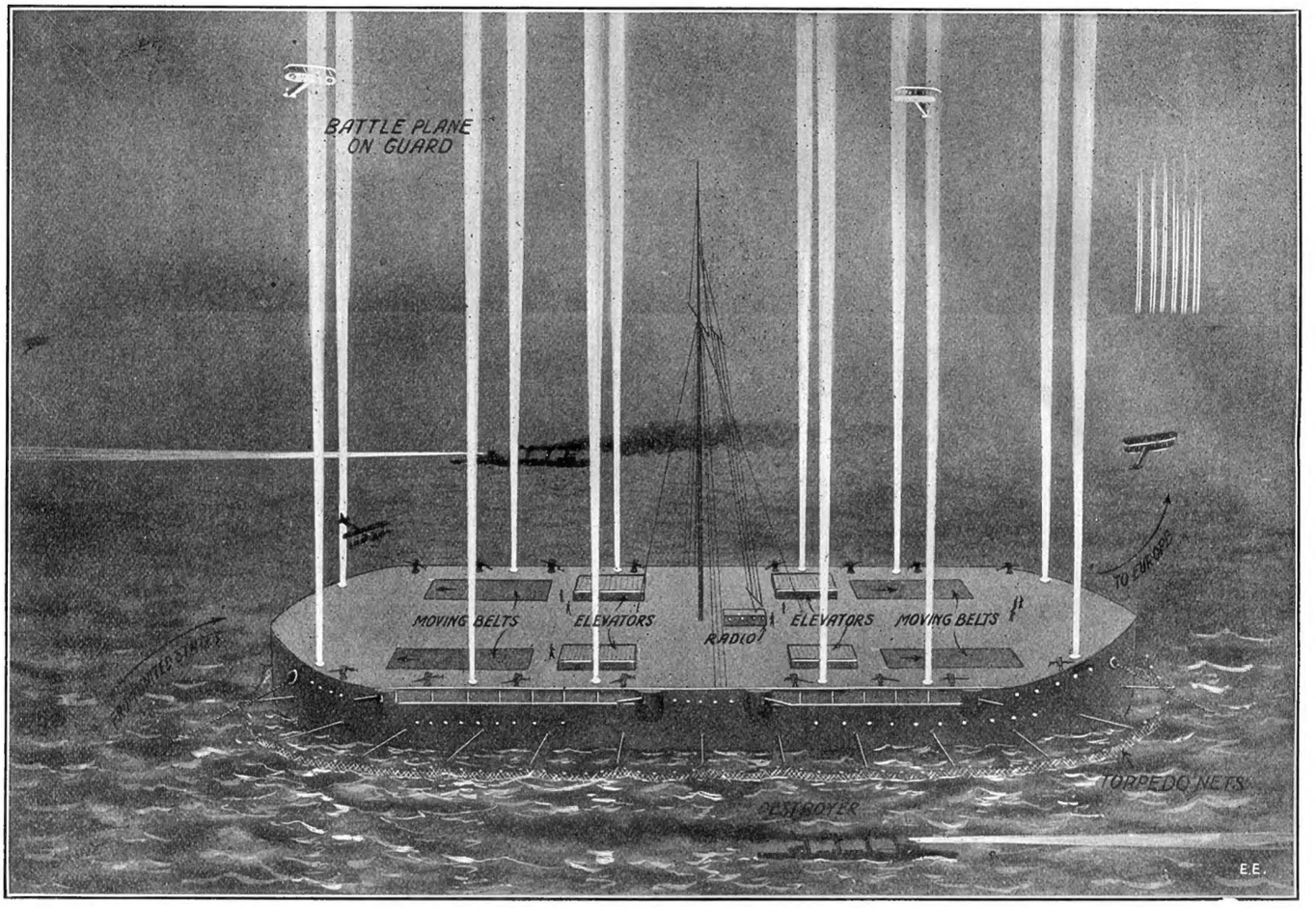
Should such craft be maintained successfully and be constructed along lines for the temporary accommodation of an endless stream of aeroplanes emanating from the shores of America en route for Europe, then, in my humble opinion, one of the most difficult of our problems will have been solved.

Under existing conditions a single pair of wings of the average type of aeroplane is a very bulky article for the hold of a ship at best, as when boxed its cubic contents would be represented by a bulk approximately three feet by five feet by thirty-five feet. Think of the tremendous storage space these alone would occupy, with the possible and even probable eventuality of their being destroyed by a submarine torpedo. Furthermore should all the parts successfully reach the shores of France or England, even then the air-craft would have to be unloaded, unboxed and reassembled, and then assigned to an aviator who had encountered the same dangers as in the instance of the knocked-down planes. Then think of the other situation by way of comparison—both aviator and airship will have reached their destination without such hazard, and both ready for immediate service when they land; the aviator accustomed to the idiosyncrasies of this particular plane—in fact having been in actual continuous service while becoming acquainted with his machine!

Suppose that it would take twenty hours of actual flight to reach the shores of France or England. The aeroplane would still have from seventy-five to eighty hours of usability left before requiring replacement of wornout parts.

The "floats" would necessarily have to be very large, with top deck free from obstructions so as to facilitate the safe landing of the airships. The process of accommodating the stream of aircraft might be

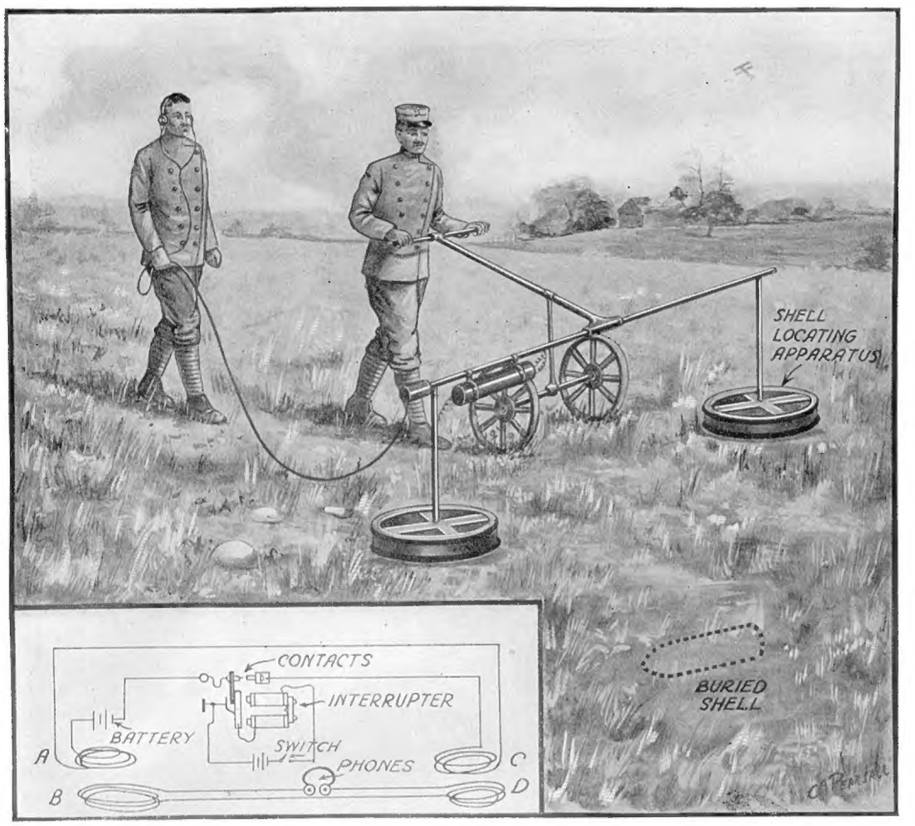
(*Continued on page 717*)



Instead of Shipping the Thousands of American Aeroplanes Across the Ocean, Mr. Winger Has Made the Unique Suggestion Here Illustrated. Namely—Have a String of Gigantic Aerial "Stepping Stones" Across the Ocean and Let the Aviators Fly Their Machines Over. These Armored Ships Could House Dozens of 'Planes at Night, When Necessary, and They Would Be Marked at Night By Powerful Vertical Shafts of Light.

Hughes' Balance Locates Buried Shells

IN the early days of the war it frequently happened that the French farmers would run their plows into unexploded shells buried a few feet in the ground, with oftentimes fatal results. One of the French army engineers thought of a novel electrical scheme for accurately locating these buried shells, thousands of which had landed in the fertile fields along the one-time firing line. His idea involved the application of an extra large size *Hughes' balance,* an instrument well knwon to every electrician. The exploring coils of this shell-locating electrical balance are mounted on a light two-wheeled truck, as shown in the illustration, so that the operatives using the device can propel it over the ground at a fairly rapid rate. The exploring work has to be done reasonably slow in order to note the indications of the instrument. The necessary battery and current interrupting devices are mounted in a substantial container on the chassis, along with the locating coils. The action of the apparatus is as follows:



Back of the Battle-lines in Northern France the Land Had to Be Tilled. Many Fatal Accidents Occurred, Due to the Plows Striking Buried Unexploded Shells, Until the Hughes' Balance "Shell Locater" Here Illustrated Was Devised.

The induction balance is composed of four coils, two in the primary and two in the secondary circuit. When the relative positions of the coils are adjusted correctly, the inductances neutralize each other and no current flows in the secondary circuit. If, however, the slightest change is made in any of the coils, such as by the insertion of any metal object, the mutual induction is unbalanced and a sound is made in the telephone receiver.

A small experimental balance for use in detecting counterfeit coins, etc., was described in the August, 1917, issue of the ELECTRICAL EXPERIMENTER. Each spool is 3½" in diameter, would with exactly 300 turns of No. 32 single silk wire, spaced evenly, layer on layer. Any difference in the windings will cause trouble when the coils are adjusted.

Fig. 2 is a diagram of connections. The secondary coils are connected in series with a galvanometer or 'phones. An experimenter who has no galvanometer can purchase an inexpensive Weston ammeter. When the shunt has been removed, this will serve very well as a galvanometer. Some form of interrupted primary circuit is necessary to induce currents in the secondary. An interrupter, mounted on the armature of a buzzer, serves for this purpose. When the key is closed the interrupted primary circuit induces a current in the secondary, causing the galvanometer to deflect until the inductances are evenly balanced.

To balance the circuits so that the inductances neutralize each other and there is no deflection of the galvanometer, it is first necessary to make sure the secondaries have the windings in opposite directions to the primaries. This done, the coils are carefully adjusted until the needle of the meter is at zero. A more satisfactory indicator is a 75-ohm receiver.

For detecting counterfeit coins, a genuine coin is placed in the hole thru one secondary coil and the apparatus is balanced. Any other good coin of the same size will also balance the inductance, but if a counterfeit is inserted there will be a deflection of the indicator, or a sound in the telephone receiver. This effect is caused by a difference in conductivity of the metals. The insertion of the coin changes the mutual induction of the coils, the amount depending on the metal. In the same way metal (iron or steel) shells are located, their presence upsetting the balance between the four coils.

The sensitivity of receivers can be compared by inserting a variable high resistance in the primary circuit. The receiver which gives a sound with the greatest resistance cut-in is the most sensitive. Of two magnets, the one giving the greater unbalancing effect when held a given distance from one secondary, and directly over the center, is the stronger.

When the difference in frequency of two alternating currents is measured, one circuits is connected to coil 2 and the other circuit to coil 4. The current in the secondary coils will give beats; that is, the sound will grow strong, then weak. The number of beats per second is the difference in the frequency in cycles. Other proposed uses for this sensitive device include the locating of submarines, mines, etc., under water.

THE PRODUCTION OF COLORED FLAMES FOR DEMONSTRATION AND EXPERIMENTAL PURPOSES.

Many people will have experienced the need for a highly luminous and steady flame in arranging lecture demonstrations of spectra and interference experiments. An ingenious appliance for this purpose is described by G. A. Hemsalech in the *Philosophical Magazine.* The flame utilized is produced by coal-gas and oxygen fed into a specially designed burner, having a series of apertures not more than 2 mm. in diameter. Thru these orifices the air-coal gas mixture passes, and by suitably proportioning the mixture a very hot non-luminous flame from 12 in. to 18 in. in length and about ½ inch in diameter may be produced. The flame can then be colored by the aid of a series of specially designed sprayers. Each of these sprayers consists of a glass vessel containing a small portion of the solution which it is desired to introduce into the flame, and allowing air to pass over the same to the burner. Two capillary tubes also pass into the vessel, carrying electrode wires of iron or aluminum. The positive electrode is central and terminates slightly above the level of the liquid, while the negative passes down the side of the vessel and passes into the liquid. The positive electrodes of all the sprayers are connected to one of the coatings of a Leyden jar, and the negatives are arranged so that any of them in turn can be connected to the other coating of the jar. An induction coil, giving a 6 inch spark, is sufficient for working these sprayers. In working the apparatus all the sprayers, except the one to be used, are disconnected. A gentle current of air is then allowed to pass and coal gas admitted until a flame is obtained which is still luminous near the tip. Oxygen is then added until the flame is non-luminous. The flame is then colored by passing sparks thru the sprayer intended to be first used. Any of the other sprayers can be connected and used instead, in succession. In this way a flame colored by any desired ingredient can be obtained. The flames thus produced are stated to be very useful for showing, in a large lecture theatre, the spectra of the more volatile elements such as Ca, Sr, K, Cu, etc.

JACK "WIRELESS" BINNS NOW A CANADIAN LIEUTENANT.

Jack Binns, who leaped into fame as a wireless hero a few years ago, is now a lieutenant in a Canadian instruction camp.

Thrill of Science in New Movies

AGAIN we have with us the ever interesting "scientific movie." At present much interest is evinced by the public in all photoplays dealing with the war, secret service and the spy element. Realizing this the studios are working day and night to gratify this craving for the sensational, and how well they are succeeding is seen by the crowds storming the doors of the "film" houses.

First and foremost we might mention a gripping drama of the German spy and espionage system just released in serial form under the title of *"A Daughter of Uncle Sam,"* by the Jaxon Film Co. The inside story of the sensational manner in which countless German spy plots and intrigues have been baffled by the United States Secret Service within the last three years is shown for the first time in this tremendously patriotic photoplay. The twelve episodes reflect the campaign of the government against the destruction inaugurated in the United States by German agents. It shows how the activities of the enemy spies have been balked in their attempts to destroy ships, munition plants, warehouses containing food and other supplies.

In the photo may be seen the spy's den and the various plotters watching a *Radio-controlled torpedo.* Jane Vance and William Sorelle are featured in the swift, rapid-fire action of this film-play.

Universal's new serial *"The Mystery Ship"* abounds in numerous thrilling situations. The story centers about a *semi-visible ship* which can travel on land, water, and in the air. To make it invisible it is painted with a substance, the inventor of which is trying to recover for the heroine a large treasure, which had been the cause of her father's long search, finally ending in his death. The treasure is very difficult to locate and the "phantom" is trying his best to get it. Eventually he has in mind the placing of the secret substance in the hands of the United States Government which is anxious to secure it for war service but wishes to recover the treasure first. The Germans are equally bent on securing this wonderful substance—thereby putting plenty of thrill and punch into the photoplay. The photo shows the "Phantom" seated in a corner of his laboratory on his scientific ship.

Artcraft pictures present a wonderful photoplay spectacle featuring the famous opera star Geraldine Farrar in *"The Woman God Forgot."* It abounds in many thrilling and tense situations, dealing with the Spaniards' early attempt at conquering the new world with all the splendor on one side—interwoven with barbaric cruelty on the other. The photo herewith shows Cortez up-to-date—Mr. Hobert Bosworth, as the Spanish adventurer Cortez, whose army conquered Montezuma and his Aztecs —at the telephone assisting Cecil B. DeMille direct the big battle scenes, showing how necessary it is to have communication with the thousands of men taking part in a "movie battle," to assure a realistic and successful "scene."

Much attention has been attracted by the new Pathé mystery serial *"The Hidden Hand."* Many startling and brilliant serials have been produced by this company and therefore the success of its latest attempt seems assured.

The story abounds in many tense situations and gives opportunity to the brilliant stars. Who is her father? That is the question a young and beautiful girl must answer. The man she had reason to believe was her father has been mysteriously murdered in his library and is also an agent of a foreign power. Before the agent dies he reveals to those present the secret of two mysterious packets and a locket which will establish the identity of the heroine, that she is a princess. "The Hidden Hand" has received news of the agent's arrival and made up one of his confederates to represent a secret service man, who is investigating the mysterious circumstances surrounding our beautiful heroine, thereby causing many complications. Others are also interested in the packet as strange provisions of the will, as yet not discovered, are suspected.

In the present photo may be seen "The Hidden Hand" in his laboratory making up one of his confederates to resemble the secret service agent and so cleverly is his work done that the fair heroine is nonplust to tell who her sweetheart is, for—"as it happens in the movies"—she is soon in love with the secret service man. On the right of the "Hidden Hand" may be seen his terrible poison gauntlet. When he so desires he can shoot a stream of poison-out gas into his antagonist's face, thereby laying him away for good.

Left Photo: "The Hidden Hand" Disguising a Confederate. Note the Poison Gauntlet. Lower Photo Shows An Exciting Moment When the Spies Use a Radio-Torpedo In "A Daughter of Uncle Sam."

Top View: The Inside of the Invisible Boat In "The Mystery Ship." Right Photo: Using the Telephone to Direct the Stupendous Film Play "The Woman God Forgot."

HEARD FROM THE TRENCHES

The officer comes up an' says, "Which one of you boys would like to have a night out of the trenches?" I steps forward, an' 'e says, smilin', "Well done, my boy, you will complete the *wiring-party* to-night."—*Sketch.*

DATE OF ISSUE.—*As many of our readers have recently become unduly agitated as to when they could obtain* THE ELECTRICAL EXPERIMENTER, *we wish to state that the newsstands have the journal on sale between the twelfth and the eighteenth of the month in the eastern part of the United States and about the twentieth of the month west of the Mississippi River. Our subscribers should be in possession of their copies at these dates. Kindly bear in mind, however, that publications are not handled with the same dispatch by the Post Office as a letter. For this reason delays are frequent, therefore kindly be patient and do not send us complaints as to non-arrival of your copy before the twenty-fifth of the month.*

A Gyro-Electric Destroyer

By H. GERNSBACK

WE are primarily in this war to win it and to win it quick. This war has demonstrated the fact that men against men result unavoidably in a deadlock. There is but little doubt that any of the men of the warring nations today are not as good as those of any other. If we are to win the war, we will win it with machinery. As this war has demonstrated and keeps on demonstrating right along, it is a conflict of machines vs. machines, and the nation that has the best and the biggest machines is most likely to win out in the long run. America with its inexhaustible mechanical resources should and can do much towards shortening the war, and it is absolutely certain that if we do not bring into the field monstrous machines capable of smashing thru anything, then the Germans will do it.

America has the resources and the brains to accomplish the result. It is simply a matter of doing it, and doing it at once. Let our officials ponder over the logic and truth of this statement. It is bound to arise again.

If proof were needed what machinery has been able to accomplish in this war the recent advance of the English by means of their ponderous Tanks before Cambrai, would be a good example. Likewise, the German 42-centimeter guns have given us a good idea that, given sufficient machinery, most any obstacle can be battered down.

It has been the pet contention of the ELECTRICAL EXPERIMENTER for years that the big machine is *the* thing in modern warfare. In our February, 1915, issue, long before the present Tank made its appearance on the Western front, we already pictured a ponderous machine that could be used to batter down not only trenches, but any kind of fortress as well. In this same issue, we also depicted a huge two-wheeled affair which we termed a "Trench tractor," and this monster was supposed to make trench warfare impossible. There was much publicity accorded these various designs as well as very much ridicule, as it was not then believed that the big machines were what we claimed for them.

Just the same, our ideas were the forerunners of the present British Tanks, and in February, 1916, the first British machine was completed and taken down to a farm near London. In this locality pits, trenches and various fortifications had been destroyed so satisfactorily by the Tank, that an order was given at once for one hundred machines. The first delivery of the British Tanks was made in July, 1916. As is well known the first British tractors went into action in the Somme offensive which began on September 15, 1916. The object of the Tanks was to drive the Germans out of some high ground running east and south of Thiepval. The Tank having the element of surprise, the Germans in the first assault were driven back quite a little, but they soon rallied, and began to shell the various slow-moving Tanks.

Now it is not our intention to minimize the results or the successes of the British Tanks, but at the same time, as we have pointed out before and insist in pointing out again, the British Tanks as constructed today do not lend themselves for major operations. They are all right for a surprise attack, as at Cambrai, and it is quite doubtful in our mind if such a performance can be repeated, as the Germans by this time have learned their lesson well.

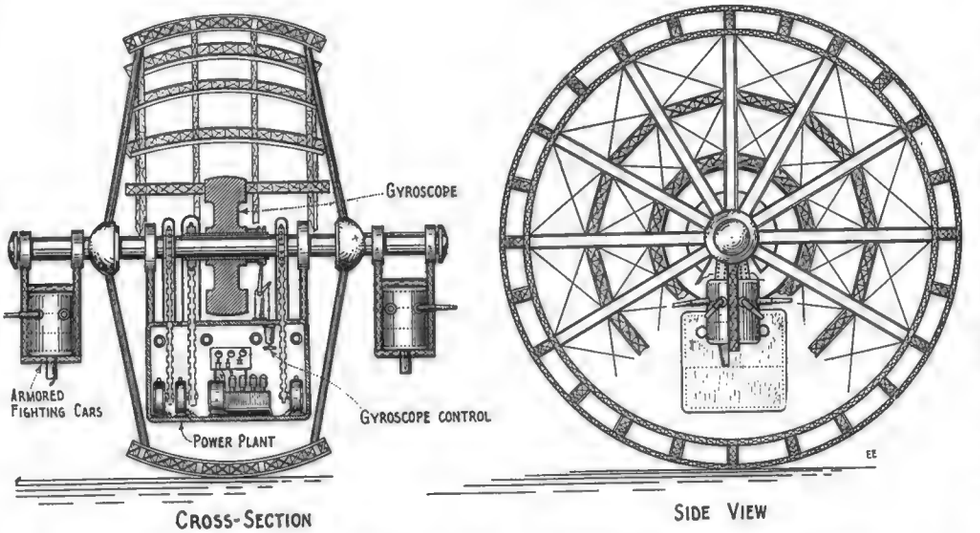
The great trouble with the Tank is its very slow speed. No tractors have been constructed so far that can move at more than eight to ten miles an hour, and as such they become easy prey to the enemy's guns which readily get the range of the slow-moving vehicles, and begin to shell them. While the British claimed no losses in the last Cambrai offensive, the Germans claim that they shot twenty Tanks to pieces. Presuming that this amount is exaggerated, there probably is quite a good deal of truth to it.

Attention is called to the fact that the movable belt tread of the Tank is quite a sensitive affair. If hit, even the bullet of a small caliber gun will almost certainly cripple the Tank. The belt is the most vulnerable part of the tractor, and as soon as it stops moving, the Tank stops moving as well, and as far as offensive work is concerned, the machine is out of action.

As we have pointed out before, what is wanted is a machine, not necessarily monstrous and weighing many thousand tons, as much as a machine that need not weigh more than the present Tank, but that can cover ground *rapidly*, so that it becomes almost impossible for the enemy to get the range.

In view of the fact that the United States Government is seriously contemplating to equip our national army with Tanks, we wish to voice our strong opposition against them, as being unfit for the important work that they are supposed to do. We have in the past issues shown designs of large machines which could batter down barbed wire entanglements and which were to be used in offensive work, but we believe that the machine here described has all the good qualities of the present Tank, but none of its many faults.

Transportation of war stores to the Western front at the present time is quite a difficult problem for the United States. It becomes a huge task just now to ship even one hundred Tanks to Europe, as they take up a tremendous amount of cargo space. In contradistinction, the machine described in this article could be shipt knocked down, the entire frame work of the wheel being made of channel iron, which takes up very little room. This is a large item, and should be carefully considered, as no doubt it will.



Sectional View Thru Front and Also Side View of Mastodonic "Gyro-Electric Destroyer." It Measures 45 Feet in Height and Can Progress Over Trenches, Barbed Wire and Gun Emplacements at 40 to 60 Miles Per Hour, Instead of Creeping Along as Do the "Tanks."

The present gyro-electric destroyer is a single steel wheel as clearly shown in our front cover and accompanying illustrations, about 45 feet high. The top of the wheel is not flat, but is in the shape of an arc which makes running a good deal easier. The wheel itself looks like a huge *ferris wheel*, and is constructed of channel steel thruout; in order to make it as light as possible, it has no continuous tread or rim but rather the steel pieces at the circumference are spaced about one foot apart, leaving a clear space for two reasons. First, the weight is cut down. Second, as our front cover illustration depicts, much better purchase is had on the ground, the machine not being apt to slip as would be the case if the top of the wheel was solid.

The wheel has one large shaft passing thru the center and extending at each side as shown in the cross-section in our illustration. This shaft is hollow and need not weigh very much. It is constructed of steel. At the hubs and at the ends of the shaft the latter is provided with armored projections, which will not be damaged in case of shell fire. In the center of the wheel is suspended the engine cab which comprises a gasoline engine of some three hundred to five hundred horsepower, the energy being fed to a generator as shown. Two of the electric motors are used for

AMONG the hundreds of new devices and appliances publisht monthly in The Electrical Experimenter, there are several, as a rule, which interest you. Full information on these subjects, as well as the name of the manufacturer, will be gladly furnisht to you, free of charge, by addressing our Technical Information Bureau.

propulsion of the wheel only; they are attached by means of a chain drive to the central shaft as shown.

It will be understood by studying the illustrations that as soon as the motors start operating, the engine cab swings forward while the wheel moves forward also. The heavy weight of the engine cab prevents it from turning a somersault as it were, but it does swing forward, and in case the vehicle is to be stopt, the cab must swing backward as shown in the illustration below. The engineer thus has it in his power to run the destroyer fast or slow, simply by changing the speed of his motors. It should also be noted that only a very moderate speed of the motors is necessary, being that the diameter of the wheel—45 feet—is so large that it will move at the rate of from forty to sixty miles with the motors running at very slow speeds. So much for the power plant.

Our attention is now called to the fact that we must steer the destroyer and steer it quickly. To accomplish this, advantage is taken of the gyroscope, which lends itself admirably to this work. The cross-section of one of our illustrations shows how this is accomplisht. A huge cast-steel gyroscope wheel is stationed on the central shaft and is driven rapidly by means of a special electric motor as shown. The gyroscope wheel while in motion, of course, prevents the destroyer from toppling over, but the writer has incorporated a new idea in the device, whereby it becomes possible with a single gyroscope to steer the vehicle. By shifting the gyroscope wheel either to the left or to the right, the vehicle will "turn" momentarily, all depending on the amount of shifting of the gyroscope, and this shifting need not be very much. If the gyroscope wheel is shifted to the right, the machine will move to the *left*. If the wheel is moved to the left, the destroyer will move to the *right*. Attention is called to the fact that this *"leaning"* is *very slight*, as the gyroscope tends to keep the machine in its upright position always. For instance, the destroyer will turn corners, not by leaning at a picturesque angle, as might be supposed, but it will actually turn corners in a vertical position, due, of course, to the gyroscope which tends to keep the wheel in its upright position always. No technical difficulty is occasioned in this gyroscopic drive or control, and any engineer familiar with gyroscope work should be able to work out the details of the machine readily.

At the two sides of the wheel we note the armored gun cabs. These can be round or square as may be desired; they hang from the shafts by means of loose slip rings. As there is nothing to hold them back, the two cabs will move backward due to their inertia while the machine is in motion; they will move forward for the same reason when the destroyer is suddenly stopt. Our illustrations show this clearly.

These armored cabs have the usual guns, the same as the British tanks, and they also have a bottom tube for the discharge of bombs as shown. All the offensive work is carried out by the two-gun cabs, the engine plant not being used for offensive purposes whatsoever. It is simply a power plant.

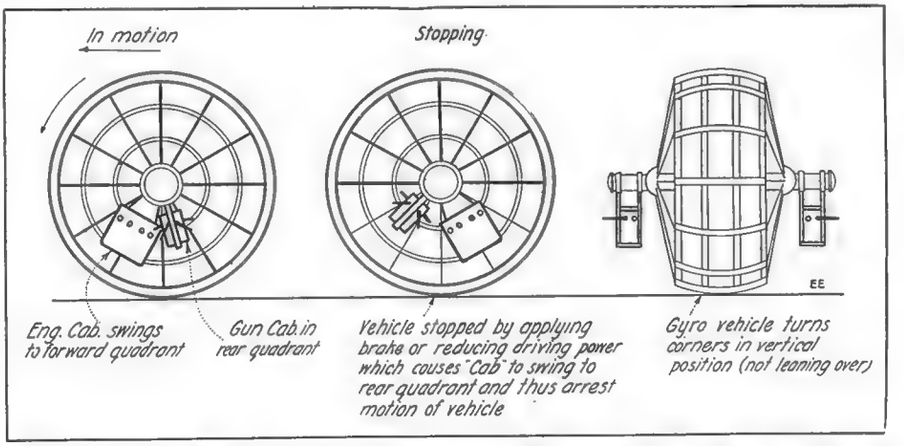
Inasmuch as the wheel of the destroyer is not solid, but made of channel steel, it will be readily understood that even a large size shell will easily pass thru the lattice work of the destroyer without doing much damage, and here is where this machine shows its superiority over the tank. It will be almost impossible to damage this destroyer by means of shell shot. Even a "dead hit" from a medium caliber gun will not cause much damage, and even a good sized shot hitting the gyroscope will not hurt it very much for the reason that the latter spins at enormous speed and will be almost certain to deflect the shot, unless, of course, it is a dead hit at right angles to the face of the wheel. The external chain drives are encased in heavy armor, and it should be as heavy as possible to prevent the machine being put out of action, and this can be readily done. It will be noted that this chain drive, the most vital part of the machine, presents but little surface to an on-coming shell. In contrast thereto you will notice the broad and very large moving tread of a British tank, which comprises almost one-quarter of the surface of the entire tank.

Reverting back to the gun cabs. There is really no good reason why these cabs are needed at all. Nor is there any good reason why the British tanks should carry guns. If the machine was at all built for offensive purposes, its weight alone would be sufficient to crush down any opposition, thereby making the guns useless. This is exactly the purpose of the present machine. Imagine this machine starting on its offensive journey. It will first smash thru all the barbed wire entanglements without any trouble whatsoever. It simply mows them down as so many match sticks, thereby cutting open a path for the infantry that follows. Suppose a nest of machine guns is encountered. Our guns become practically useless, for if the destroyer runs over the machine guns or even threatens to do so, the enemy must of necessity abandon the guns, and the destroyer "walks" over them, crushing them into the ground. The same is the case with the large size guns. You may be quite sure that if the gunners see the machine coming, they will most certainly abandon their gun, and in this case the destroyer is powerful enough to run over the gun, thereby putting it out of action.

This machine is not designed, as might be supposed, to kill off as many of the enemy as possible. That is not at all the purpose of the machine. It is simply to put out of action other machines, preferably guns, not men. Its first purpose is to cut down barbed wire entanglements—second to run over artillery, thereby putting it out of action. If we employed enough destroyers, it can be readily conceived how the enemy must invariably retreat as soon as these machines begin to advance, for the enemy denuded of all artillery must give up ground.

Some of these destroyers would, of course, be used to run parallel to the trenches, and here is where the gun carriages of the destroyers would come into their most effective work. They could drop bombs into the trenches as well as spray the occupants with machine gun bullets in order to demoralize the men in the trenches. It would become a more or less simple task to take trenches by means of this machine, but, of course, the most important part would be to destroy the larger artillery behind the supporting lines of the enemy. This the huge machines would do without any trouble whatsoever. There is practically nothing known today that could stop the progress of the destroyer. Of course this machine cannot climb steep mountains, nor ford deep rivers, but then the present tanks can not accomplish this either. But the gyroelectric destroyer can run up a hill by taking a zig-zag or oblique course. Rivers that are not too deep can be readily negotiated by running thru them obliquely, not fording them at right angles.

We are quite confident that a machine of this kind should do as good work as a thousand men in the field, and, perhaps, better.


In motion
Stopping
EE
Eng. Cab swings to forward quadrant
Gun Cab in rear quadrant
Vehicle stopped by applying brake or reducing driving power which causes "Cab" to swing to rear quadrant and thus arrest motion of vehicle
Gyro vehicle turns corners in vertical position (not leaning over)

Diagrams Which Show the Action of the Suspended "Engine Cab" and "Gun Cabs" When Gyro-Electric Destroyer Is In Motion; When It Is Stopped and When Turning Corners.

NEW CODE RULE WILL REQUIRE POLARIZED WIRING.

At the recent meeting of the Electrical Committee of the National Fire Protection Association for revision for the next edition of the National Electrical Code, it was voted to change Rule 26*a* as follows:

"The neutral conductor of all three-wire circuits and one conductor on all two-wire circuits must have an identifying insulating covering readily distinguishing it from other wires. This wire must be run without transposition thruout the entire installation and properly connected at all fittings to properly identified terminals in order to preserve its continuity. When one of the circuit wires is to be grounded, the ground connection must be made to this identified wire and as prescribed in Rule 15 and 15*A*."

This rule will appear in the new edition of the Code, to be known as the 1918 edition, and does not become effective until January 1, 1919. All fittings having wire terminals, such as sockets, receptacles, cut-out bases, attachment plugs, etc., must have some identifying mark to enable them to be easily connected with the proper terminal. Therefore, the organization known as the Associated Manufacturers of Electrical Supplies has submitted the matter to members of all of its sections covering the devices affected, asking that proper committees be appointed to consider the matter and report results at as early a date as possible, in order that they may be fully prepared for the new order of rules when in effect January 1, 1919.

"The Deluge"—The Show That Electricity Made Possible

By GEORGE HOLMES

ARTHUR HOPKINS, who has presented the critical public with many successes, has outdone himself in "The Deluge"—one of the best acted and intensely interesting dramas ever presented upon the American stage. Even tho it comes at a time when all the world is in a turmoil, the play serves to illustrate the law of human nature truer and more realistic than anything seen in years. Many fine bits of side-play are shown between members of the cast and a number of tensely gripping scenes help to make the play one of the distinct successes of the present theatrical season.

The play deals with the various emotions that will grip a number of persons with widely disassociated traits and vocations when thrown together and facing death, who try to make in their last moments reparation for past transgressions, striving hand in hand to whisk death away from their doorstep. Suddenly, finding themselves face to face with the fact that the danger is past, they forget all their good intentions and fall back into paths of so-called civilization, completely ignoring each other as in the past. A play with a moral that is strikingly told.

It is not my intention to dwell on the merits of the drama more than is necessary to give the reader the basic theme upon which the play is written.

I wish to convey the danger that faces the characters in the story, which by the fascinating science of "stagecraft" is carried out in a remarkably realistic manner.

In the first act the various persons are drawn to a cafe, not of the ordinary sort, but one whose regular life only begins at midnight, behind closed doors when all the world is asleep. Reports have been circulated that a cyclone is on its way and general apprehension is felt as to whether the dams on the river above the town will hold. Suddenly, without warning, the terror strikes the town, and all rush to safety; the various persons trapt in the cafe are expressing the chances of the dam's holding; amongst their number is a lawyer who has participated in a graft contract on the construction of the dam and who realizes that it will not hold if the storm continues to last much longer, and so informs those assembled. Immediately there is a panic, but he takes the upper hand and orders that everything be securely locked. Iron shutters on the windows and doors are lowered by cranks, etc., which make the room absolutely water-tight; in other words the people are shut up in a living tomb—then the big crash comes of the dam bursting and loosing the torrents of water over the town. For a whole night the suspense continues, their fates in the balance, and gives rise to some very fine portrayals on the part of the actors in the cast.

Now as to the mechanics of this stupendous production—and believe me the effect of the deluge striking the town sure does sound like the "real stuff," when you're sitting "out front"—which far surpasses anything done heretofore in this direction.

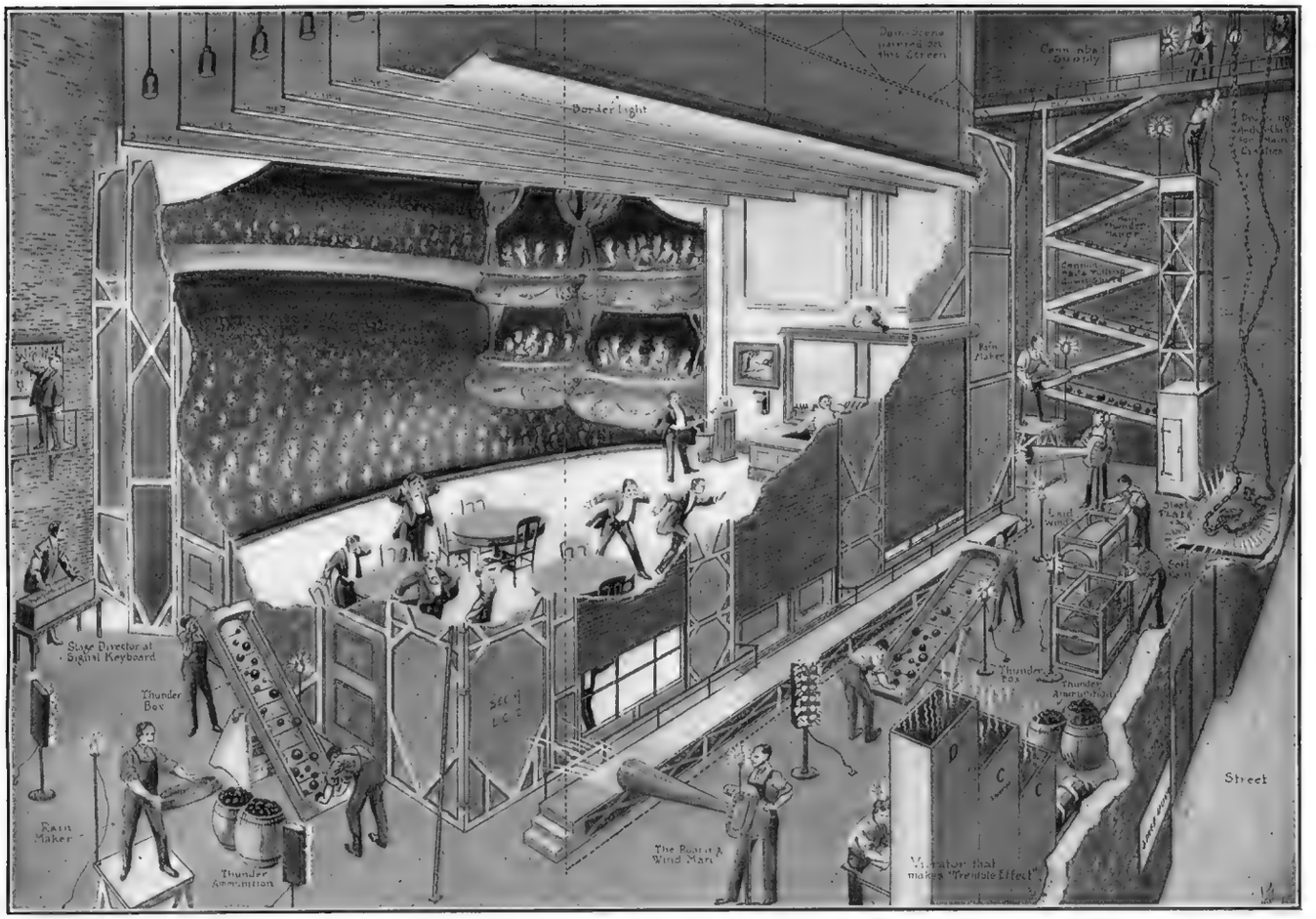
The stage has always held for most folks, be they old or young, a certain thrill of fascination and mystery. They see marvelous effects, experience novel sensations and then wonder how it is all done.

The people who produce the effects and all "show folks" in general have an unwritten law about divulging details of the how and why of things, and, therefore, much of the mystery still remains. Only in rare instances are the uninitiated so fortunate as to be allowed a peek back of the "curtain" where the make-believe and mystery-producing scenes of Theaterdom take place.

Having been intimately connected with stage life for a number of years, the author takes pleasure in giving the general public an insight as to the rôle played by modern stagecraft in this recent New York success.

"Back stage," all the space available is devoted to the miscellaneous apparatus necessary to produce the effect of the "Deluge."

The innumerable cables, braces, stands,



"The Deluge"—a Master-piece of the Theatrical World Recently Pro duced in New York, Involved the Application of Dozens of Electrical and Allied "Stunts" to Keep the Audience on Edge. To Give the True Effect of a "Bursting Dam" Nineteen Men Are Required, Some working the "Wind" Machines, Others Rumbling Cannon Balls Up and Down a Chute, and for the "Big Noise" a Full Size "Anchor Chain" Is Dropt Forty Feet Onto a Steel Plate!

NEW ELECTRIC FOOD VENDING MACHINES.

Automatic self-service restaurants are very popular in large European cities. We have also in some of our more prominent American cities a limited number of them. Automatic self-service in restaurants has great advantages over other restaurant systems. The most important ones are improved sanitation, quicker service and the elimination of tips and delaying waiters.

In the present device the coin inserted is accepted or rejected, depending upon whether or not there is food in the chamber. A signal-system is operated to notify the attendant of the need of refilling and the sales recorded, all of which represent entirely novel features, assuring an absolute control of each individual purchase, collectively showing the volume of sales. This recording-system makes it possible to operate an unlimited chain of restaurants. Moreover, the recording-system is put up in the form of an electric panel indicator in the manager's office, who can by this method see at a glance how his business stands at any hour of the day. Then again, when the attendant refills the empty compartment, all these operations are reversed.

All of the operations mentioned above are accomplisht thru the employment of electro magnets, which may be of the two-pole horseshoe type or may be of the ironclad solenoid type. These electro magnets are placed below the table level and the physical pull exerted by them is transmitted to the compartments above by thin steel rods operating a rocking arm or shaft. These shafts are concealed in horizontal bars supporting the glass shelves on which the food is displayed. The locking mechanism is also concealed in a hollow framework, so there is actually no mechanism to obstruct the light which illuminates the food from all sides. Heating is done electrically.

New Automatic Electric Waiter—Drop Nickel in Slot—Out Comes the Pie!

France imported $12,221,300 worth of electrical materials during the year 1916.

AUSTRALIAN RAIN STIMULATING DEVICE.

The Commonwealth Government of Australia, thru Mr. W. A. Watt, Minister for Works and Railways, has decided to install two Balsillie plants for the stimulation of rain in Victoria and in New South Wales, in the Mallee and Riverina districts respectively.

Mr. J. G. Balsillie, an Australian, has become famous for his inventions in wireless telegraphy. He has now carried his inventive genius into the domain of rain-making or rain-stimulating by means of high tension electricity liberated in the upper atmospheric strata. As a result of official trials made with his device at Bookaloo, 50 miles west of Port Augusta, an increased rainfall of between 50 and 70 per cent has been noted there. Having examined the results of a year's experiment, Mr. Watt has been very much imprest with the possibilities of Mr. Balsillie's invention. The vast importance to Australia of a successful method of rain-stimulation has been recognized by the Minister, hence the new tests which will be made.

LINEMEN IN INDIA MUST EAT.

It is said that the native in India is extremely particular about regularity in his meals; once accustomed to eating at a certain hour he must stick to it at all costs. An English engineer had an awkward experience of this when erecting a 100-foot steel pole with the aid of about 30 natives and the minimum of tackle. The pole was halfway up when the "headman" intimated that it was dinner time. Only the most desperate entreaties, coupled with threats, prevented the men letting the pole come down with a run, tho it had taken several hours to get it into this position.

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spotlights and maze of ropes would test most people's ingenuity, particularly those unacquainted with life behind the scenes.

In this particular production every available bit of space is utilized. The scene proper is what is known as a "box set," and is a permanent arrangement thru the three scenes of the play.

Details have been given strict attention, and the lowering of the iron shutters to make the place watertight is a most ingenious arrangement, the audience being able to see the shutters slowly descending as the ratchets and cranks do their work—noisily and dramatically. Now for the "big stuff":

Seated at a keyboard provided with numerous "tell-tale" lamps, the stage manager signals to the various men stationed in distant nooks and corners, to produce whatever effect they have charge of at the critical moment or moments. Near each stage hand is set a signal lamp in series with a tell-tale lamp on the stage manager's keyboard, and both work together. It requires nineteen men to produce the "atmosphere" of the deluge!!

Some "work" large trays, made of resinous wood and resembling the shape of a cheese box cover, with very small peas in the same. These trays are held in both hands and worked around in a rolling motion, thereby giving the effect of *light rain,* and may be seen being used by the men on the slightly elevated stands or platforms. Next comes our *heavy rain* machine made of a stand in which is suspended a drum made of fine mosquito screening and inside of the drum a few pounds of small peas are thrown; when the drum is revolved by means of a crank the sound effect of heavy rain is produced. The *wind making* machine is nearly the same as the rain machine excepting that the drum is made of large chicken wire over which a strip of canvas is thrown weighted on one end so that it bears against the drum. When the drum is revolved the friction exerted against the canvas gives the effect of wind. For *shrieking wind* a large hand blower such as used by riveters and blacksmiths is utilized, and the wind is sent thru a number of chambers and then out thru a large horn; when the handle is turned swiftly a loud shrieky wind effect is secured. And now for our "big slam"—large wooden troughs are used for the rumble effect and are about ten feet long by two feet wide with zig-zag slats on the bottom to bounce the cannon balls as they are rolled back and forth.

The mighty rumble of the dam bursting is made by having a similar arrangement of troughs extending from the top of the "fly gallery" (about forty feet) down to the floor of the stage, as shown in the picture which, in this case, were attached to a zig-zag stairway leading to the dressing rooms. When the "thunder-man" is signaled he lifts a small door in a big case containing all sizes of cannon balls, and permits a choice quantity of them to run down thru the zig-zag troughs, with a resulting sound climax that resembles General Byng's smash thru the "Hindenburg Line"—tanks and all—and then to top it off a life-size anchor chain is dropt from the fly-gallery on to a large iron plate, making a never-to-be-forgotten crash! Besides all this there is an immense *tremble machine* built like an organ, which when set to going gives you the creepy feeling that the building is about to collapse! The machine is worked by a giant electric blower and air compressor, which equipment is located in the cellar with pipes leading up thru the floor to the machine proper.

Add to all this the mass of paraphernalia, cables, curtains, etc., actually used and it certainly looks like one big confusion, but to those who are acquainted with all the details, little of the seeming disorder is noticed, for by a systematic routine everything happens so that all ends well and "they are happy ever afterwards!"

MEMORIAL TO DR. ALEXANDER GRAHAM BELL.

The memorial erected in honor of Dr. Alexander Graham Bell, and his invention of the telephone in Brantford, Ont., Can., was unveiled in that city October 24, in the presence of the Governor-General of Canada, the Duke of Devonshire, and other distinguished persons. Doctor Bell was present and took part in the ceremonies. Mr. Theo. N. Vail, president of the American Telephone and Telegraph Company, had been invited, but sent his regrets at not being able to be present. Bell telephone interests were represented by other gentlemen, however.

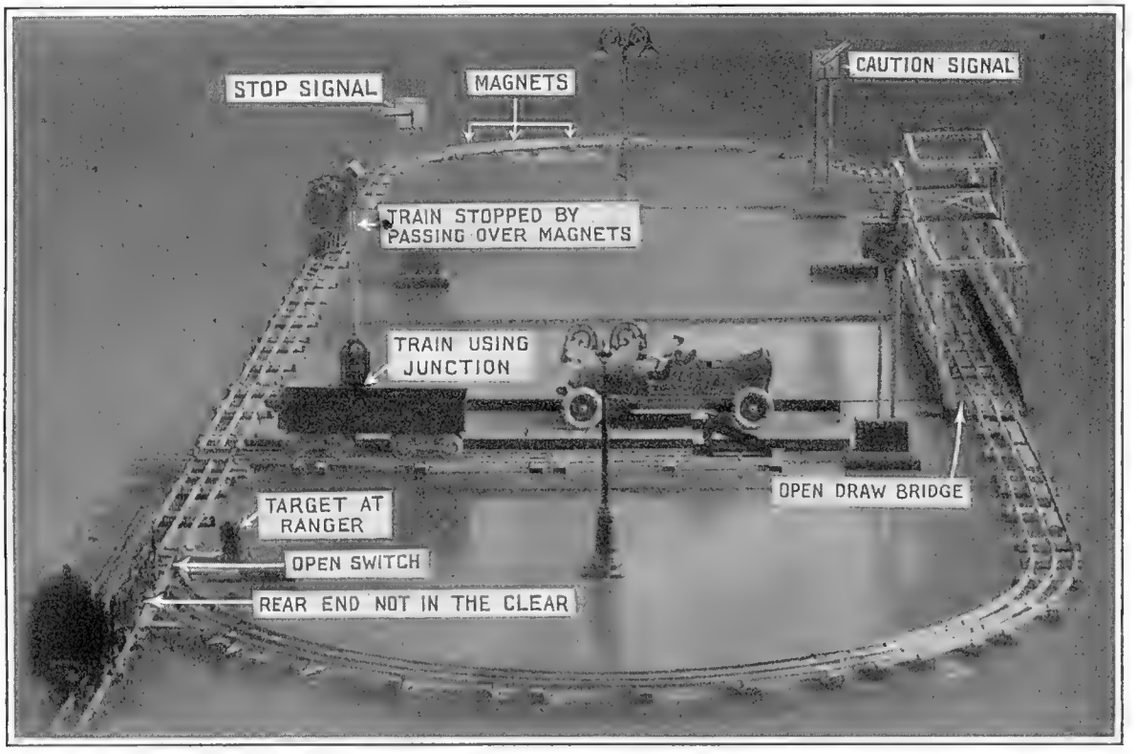
The memorial cost over $25,000, while the total outlay for the grounds and Bell homestead, dedicated as the Alexander Graham Bell Gardens, represent a cost of $65,000.

COLONEL J. J. CARTY NOW IN REGULAR ARMY.

J. J. Carty, chief engineer of the American Telephone and Telegraph Company, and lately appointed senior major of the Signal Reserve Corps, has been appointed by President Wilson a colonel in the Signal Corps in the regular army of the United States, to rank as such from August 15.

A New Electro-Magnetic Train Stop

THE numerous and varied failures made by American inventors seeking to perfect automatic *train-stops* and *controls* to eliminate railroad wrecks, have spread abroad pessimism on the subject, which has suddenly been dispelled by the advent of a new electro-magnetic method, known best among railroad men as the M-V system. It has been pronounced technically and practically invulnerable by government and railroad authorities, and promises revolutionary changes in the present method of operating trains, so its sponsors state.



The Efficacy of This New "Electro-Magnetic Train Stop" Is Demonstrated By Its Inventors With the Aid of This Complete Miniature Electric Railway System. If the Engineer Fails to Obey the Signals the Track Magnets Act To Cut Off the Steam and Apply the Air Brakes.

Never have the railroads hauled so much government property as during this war, and the tens of millions lost in wrecks in the past few months has incited war conservators to support the new system as a war measure. Inasmuch as it is a simple tho peculiar adjunct of the present block signal systems it can be installed quickly and inexpensively.

A danger condition in any given block energizes a *field of electro-magnets* of a new type placed in the track at braking distance from the semaphore in the approach block, and also a *field of magnets* at a given distance from the "caution" semaphore. The *last* field reduces the speed of the train to a predetermined rate, while the *first* field operates a stop under service application of the air-brakes, regardless of the presence of either engineer or fireman in the engine cab. It works equally well on either steam or electric railways. See Fig. 1.

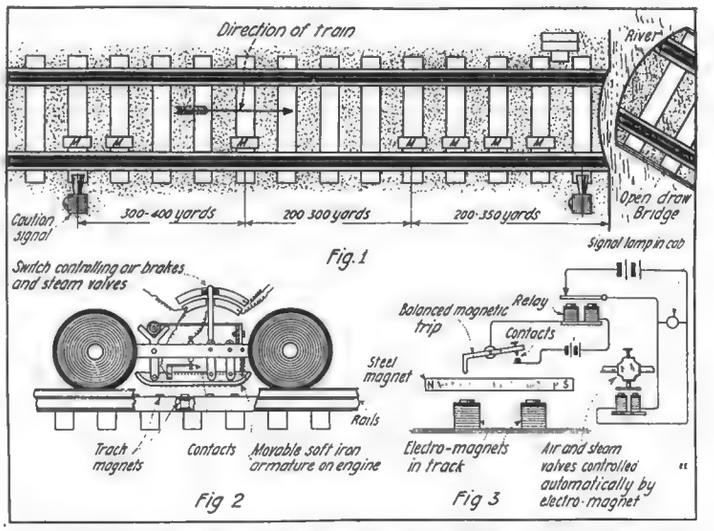
At present danger of a head-on, rear end, side-swipe or crossing collision, or a broken rail, open bridge, open switch, rock, snow or land slide, wash-out, burned bridge, etc., in "A" block causes the operation of a "stop" signal in "B" block and a "caution" signal in "C" block, all of which are worthless should the engineer be unable to see them thru smoke, fog or snow; or should he be sick, injured or dead in the cab, or should he misunderstand or purposefully disobey them. The present signals are operated by circuits in the rails—low voltage currents too weak to leak across from right rail to left rail by creepage or any contact lighter than the wheels of a loaded hand-car.

The M-V system operates with these same low voltage currents without additional installation save that the current from semaphore battery or feed wire is relayed from battery well or supply station to the field of track magnets. The magnets have the form of a square "U," with short poles of precise ratios to the bulk thereof. As a new result the low voltage current in its transit thru one of these magnets secures a remarkable distance traction that enables the magnet to pull positively thru any known substance of several inches thickness.

Present M. C. B. standards require three inches clearance on trains, the cow-catcher being carried at that and everything else being higher. At four inch clearance the M-V system suspends a long bar of soft iron, preferably suspended in one of its designs, see Fig 2, by swivels, from the axles of the forward trucks of the tender. As the magnets are housed and fixt in the track and do not move to operate, they are not interfered with by snow, sleet, ice, debris, etc. When the engine and tender pass over an energized "caution" track magnet, the soft iron armature is pulled downward (or else released upward, if deënergized magnets are used for danger signaling and control), closing for an instant the control contacts (Fig. 2), thus applying the brakes partially for a moment. The "stop" track magnets will cut off the steam and apply the brakes.

In another, newer arrangement, the armature bar under the engine does not change position in its function and the same natural conditions such as snow, debris, etc., do not affect it. It is a member of a closed circuit on the engine from the moment the engine leaves the round-house. On the top of it, so housed that it is independent of oil, gas, speed, shock, oscillation, vibration, or foreign current—rides a balanced trip or trigger with one end held to the bar by the magnetism of the steel bar. When the bar passes at either low or high speed over an energized M-V track magnet, the bar partly demagnetizes in the usual way and the trigger falls by the infallible law of gravity, breaking the closed electric circuit on the engine. This sets the cab air and steam valve actuating device in operation.

(*Continued on opposite page*)



This Diagram Illustrates How the Electro-Magnets Are Placed Along the Track at Danger Points so as to Act Gradually on the Train's Air Brakes. Also Two Methods of Applying the Magnetic Action.

JAPANESE WARSHIPS USE RADIOPHONE.

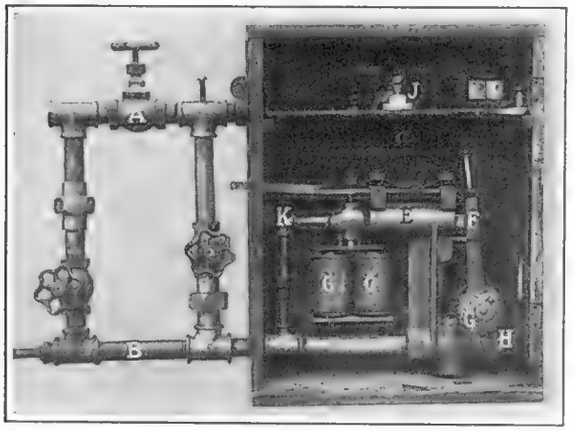
Many of the largest Japanese warships have been equipt with wireless telephones, which operate successfully for distances up to 100 miles.

(*Continued from opposite page*)

The main function of this cab device is to turn off the steam (or electric power) instantly and to begin a service application of the air-brakes. On an electric locomotive the breaking of the circuit automatically breaks the power circuit. On a steam locomotive the breaking of the closed circuit turns a valve in front of the throttle. The service application of the air brakes is more involved.

In the cab device, which occupies but a square foot of cab space, are two small solenoids operation on the closed circuit. The breaking of the closed circuit releases a small superimposed armature which by spring action makes a new contact that energizes two larger solenoids; these draw downward a transverse bar serving as the foot of a plunger carrying a pin valve, that by the descent of the bar is drawn into line with the duct of a small divergent line from the train pressure pipe. The air from the train pipe passes thru the pin valve into a cylinder and operates against a piston which actuates a lever that gives one reduction of the air pressure by a valve to the open air, and then exhausting, returns by spring pressure and gives another reduction and so on till the train comes to a complete standstill *smoothly*, without sliding of the wheels or destructive jar. The amount of each reduction is predetermined according to the length and weight of the train, by a special ratchet movement on the lever to which various wheels are adjusted, notched for from six to one hundred cars or more.

The system is immediately valuable in that it enables the big steam railroads of the country to put into speedy operation the same operative protection which has given absolute satisfaction in covered trackage in the New York subways, Boston and London subways and the Hudson & Manhattan tubes since their construction, without one collision, loss of life or money. It is prospectively revolutionary in that railroads are now enabled to "get" from the track into the train infallibly at any point of line under all weather conditions. It is possible to run a train from New York to Philadelphia today without either engineer or fireman, say the inventors of this new method of "stopping a train with a magnet," and it may soon be practicable.



A Full Size Model of the "Cab Device" as Demonstrated by the Inventor. It Automatically Shuts Off the Steam and Applies the Air Brakes.

EGGING ON BUSINESS BY ELECTRICITY.

Off with the old, on with the new. Grandma's method of guessing the egg is 99 per cent pure fails to pass the censor today. Modern methods have egged off the old ideas, and today efficient electricity has the call, saving time, temper and trouble.

Here are nimble fingered, keen eyed egg testers, separating the false from the true by means of electric egg candlers, operated on ordinary house lighting circuits. The electrical egg tester never lies. Its hidden eye and supersensitive nose rout out hen products that are inclined to "cheat."

This form of commercial electrical inspection dispells the doubt and guesswork, speeds up shipments, cuts labor costs and is helping Hooverize cost-to-customer.—*Photo Society for Electrical Development.*

Here We See Nimble Fingered, Keen Eyed Egg Testers Separating the False from the True by Means of Electric Egg Candlers, Operated from the Ordinary Lighting Circuit.

MANY NOVEL PATENTS ISSUED IN YEAR.

Invention in this country reached high-tide during the calendar year 1916. Forty-two thousand separate patents were issued to inventors by Uncle Sam. It is not the number of patents issued, however, that is worthy of note, but the character of the inventions. The patent office deals with all the efforts of the world in every field of industry to advance the useful arts. Great interests are involved, not merely of private, but of public concern, in the discoveries that are listed with the patent office.

As an illustration of what the discoveries of the 12 months mean, reference may be made to the fact that one concern in Chicago reports that it has effected a reduction in coal consumption from nearly seven pounds a kilowatt hour to 2.7 pounds a kilowatt hour, as a result of a new invention.

A New York rapid transit company introduced improvements in the year which, according to the patent office, have caused a drop in coal consumption from 2½ pounds a kilowatt hour to 1½ pounds a kilowatt hour.

An electric plant, thru some new invention, it has shown, is now able to generate electricity from coal more cheaply than can be done from the waters of Niagara Falls, says *Patent News*. These great economies are due in large measure to new inventions relating to automatic stokers and regulators attached to furnace construction, to forced draft and to coal-handling machinery.

The year brought new and valuable inventions that had to do with wireless telegraphy, telephony, the control of torpedoes, searchlights and gun pointing, vacuum cleaning, X-ray apparatus, liquefaction of air to produce oxygen and nitrogen for commercial use, flying machines, the moving picture and mercury vapor lamps.

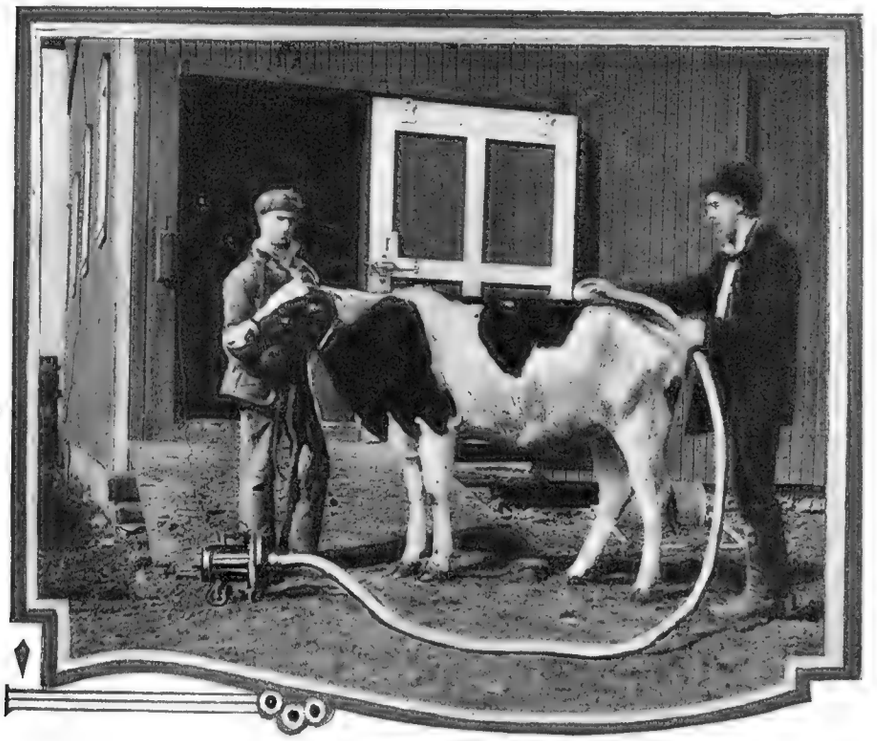
For a period of some five years an industrial fellowship maintained by trained scientists have devoted their time to the study of methods of bread-making, with the object of producing better bread. In the last calendar year, certain of the processes developed thru this study were patented and put into operation.

Better nourishment of the yeast has reduced the amount required in raising the bread and maturing the dough, with the consequent lessening of the amount of flour and sugar used up by the yeast and converted into carbon dioxid and alcohol. The savings of these and other economies to those employing the novel processes patented during the year are estimated to amount to more than $1,000,000 a year. This estimate is based on the present high scale of prices, but on any scale of prices would, it is asserted, be enormous.

The patents in the electrical field during the year were numerous. In the field of farming implements there came the improved tractor engines, better apparatus for digging, irrigation and drainage canals, improved beet harvesters, and thousands of other useful as well as interesting ideas.

Bossie Gets An Outdoor Bath

One of the most menial tasks about the farm and dairy is that of keeping the cows clean. Progressive dairies are rapidly awakening to the fact that a small electric vacuum cleaner of the portable type will soon pay for itself in performing this duty. A few deft whisks of the vacuum cleaner tool over Bossie's hairy coat and she's as clean as a whistle. It is doubtful if there is any other method which can approach this one for cleaning the coats of such animals as the cow.



Photos courtesy of Society for Electrical Development

If There Is One Job That the Boy on the Farm Detests—It Is Cleaning the Cows. And Modern Dairy Regulations Demand Extreme Cleanliness from the Cow, Down to the Final Product. Wherefore We Learn That Dairymen Are Now Using Electric Vacuum Cleaners for Keeping the Cows Thoroly Clean.

A small electric motor, costing but a few cents per hour to run, drives the highly efficient vacuum suction brush. This treatment has been found to promote sanitation and health among cows as well as horses. The new device does away with the laborious as well as unsanitary task of curry-combing the cattle to produce the rich, full coat which the experienced farmer accepts as a sign of good health.

The electric vacuum milker is another of the modern devices which have proven a god-send to the dairymen. The second illustration herewith shows the 20th century way of milking cows. All the attendant has to do is to attach the four suction nipples to the cow's teats, the machine does the rest. It milks the cow more quickly than the old-fashioned method and is more sanitary in every way.

ELECTROTHERAPY HELPS CATARACT OF THE EYE.

If there is one ailment that has baffled treatment by either surgical, mechanical or electrical treatment it is cataract of the eye. Many people, especially older men and women, go permanently blind with this trouble. It is, therefore, that we read with gratifying interest of a successful electrotherapeutical treatment of such a case and which is discust by Dr. Moses G. Campbell in the *American Journal of Electrotherapeutics and Radiology.*

The patient, Mrs. W., was free of these troubles and had a vision of R. E. 20/100, L. E. 20/70. We had then a favorable case. *Treatment* was commenced February 11, 1916. Radiant light and heat, autocondensation and galvanism were used. During the first month I had difficulty in securing a proper electrode. I then used radiant light and heat. The patient failed to improve during this time, and complained of pain in the eyes. The light was then omitted. Autocondensation was given thruout the treatment with the idea of improving the general nutrition of the patient who was in a rundown state on account of a spell of grippe, and to relieve or improve her rheumatoid condition of hands and feet.

Galvanism was the main local agent used. The mode was negative pole to the eyes and positive to the back of the neck.

The electrode that gave best service was made as follows:

The pad to the back of the neck was 3" x 6". Material used was four layers of absorbent cotton covered with two layers of silent or underlay table cloth, and finished with two layers of gauze or cheese cloth. This was soaked in a solution of sodium bicarbonat (ordinary baking soda) 3ii to a quart of water. To make the connection with the rheophore and the positive pole a carbon terminal was used instead of metal in order to avoid any possibility of *metallic ionization.* This carbon terminal was a portion of the carbon element of an old sal-ammoniac cell. The spring from an old dry cell was fastened by a screw to the carbon and used to make the connection with the conducting cord. I have found this spring very satisfactory means of making connections for electrodes. The electrodes for the eyes were of copper gauze wire twisted to form a stiff centre piece with flat ends the size to cover the eyes. The center was covered with adhesive plaster, the eye pieces with 2 layers of absorbent cotton, then two layers of silent cloth followed last with cheese cloth.

These electrodes for the eyes were well soaked in a 2% sodium chlorid (common table salt) solution and kept wet thruout treatment by applying the solution frequently with a dropper. Mode of application was three (3) to ten (10) milliamperes twenty minutes daily, six times a week.

Fifteen treatments were given in February, 27 in March, 23 in April, 16 in May, 7 in June, making 88 treatments given during five months.

Results. The oculist's report was as follows:

"On first examination patient reports a haze or cloud before both eyes, being unable to see clearly with glasses. She noticed about the last of March a marked improvement in clearness of vision, that 'the cloud' before eyes was not so great. My impression was that in June when she left Atlanta that the cloud had about disappeared. With the ophthalmoscope the cataracts appeared not so dense."

He admitted that the improvement was beyond his expectation and was such as to enable him to make her vision practically normal with glasses—1.50 sph.

At the time treatment was discontinued, she could see objects clearly. Her home oculist examined the eyes and told her she would never go blind.

To Milk Fifty Cows Used to Be a Job for Ten Men—Now One Man Can Do the Work—Thanks to the Electric Vacuum Milker Here Illustrated.

Telephone Switchboards of Yesterday

HELLO, Central, give me Rector four-six—four-two! Thus speaks the twentieth century business man—and in ten seconds he is in telephonic communication with the desired party. That is, if Central is feeling right and the line is not busy. But imagine the exasperation of the business man of 38 or 40 years ago, who could count himself lucky indeed if he got his party after half an hour of arguing with the "Central boys"—who, we are told, often became so flustered that they sast the subscribers back in several languages.

The telephone probably furnishes the most impressive object-lesson in development in the comparatively few years of its life, but the switchboard has undergone the most remarkable metamorphosis of all.

The illustrations herewith are exceptionally interesting in that they bring the old and new types of central telephone exchange switchboard into strong contrast, and many people will be inclined to remark, "Is it possible that such changes could have taken place in telephone switchboard development within forty years?" But the world has been moving forward with rapid strides since Dr. Alexander Graham Bell first brought his telephone to the attention of the skeptical world, in 1876.

In Fig. 1, is shown the appearance of the first commercial telephone switchboard,

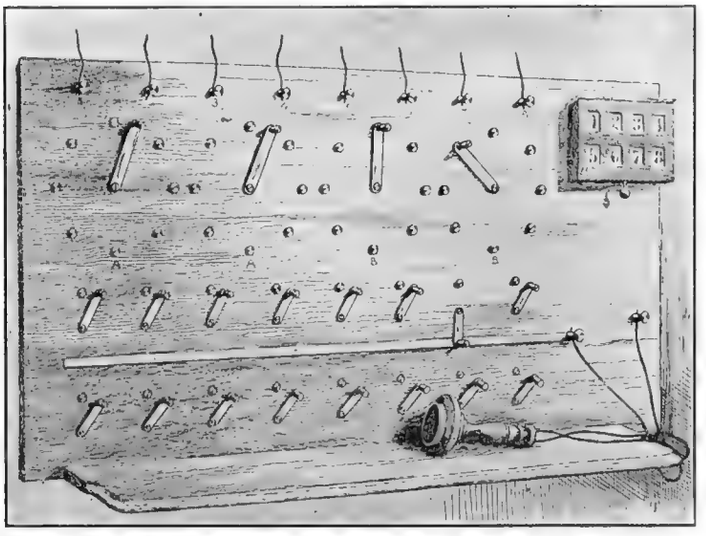


Fig. 1. The First Commercial Telephone Switchboard. It Was First Used in New Haven, Conn., Jan., 1878, and Had Connections for "Eight" Subscribers.

used in New Haven, Conn., in January, 1878. It had connections for eight subscribers, as shown by the call box on the upper right hand corner. The names of these eight subscribers ought to be engraved on the rolls of fame for their faith in the telephone promise.

As becomes evident to any electrician this telephone switchboard resembles the "attic" laboratory switch panel of one of our later-day electrical "bugs." The telephone receiver shown was made of wood, and it is indeed interesting to note that while the modern telephone switchboard bears a resemblance to the old-time board, in name only, the telephone receiver remains almost identical to the one you see in this historic illustration. It shows that Dr. Bell had the right idea from the very start.

The early switchboard shown at Fig. 2, bears the date of 1878 and was used in establishing the first telephone system in Chicago, Ill. It was put in operation in August of that year. Fig. 3 is a photograph of an early American telephone switchboard of unknown date. It apparently possest several advantages over the first types used, judging by the elaborate arrangement of the connecting jacks.

A good idea of the early telephone switchboard is given in an article in *Electric Industries* by Mr. James G. Lorrain, one of the pioneers in English telephone developments. Mr. Lorrain says in part:

"The Manchester (England) Exchange was the first (July, 1879) telephone exchange in Great Britain, and indeed in Europe. The switching apparatus consisted of a Williams' (American make, as devised by T. A. Watson) 'standard' switchboard, as it was called, and a separate operating table. Two operators were required to work 75 lines. One sat at the table to receive calls and *shouted them out to the other operator,* who plugged the lines together at the switchboard. The noise in a switchroom fitted with a number of such operating tables may be imagined when it is considered that one "Central boy" had to shout the number to another boy at the plug board, situated about 10 to 12 feet away! In 1879 and 1880 New York City had some of these telephone exchanges installed and working. These switchboards were of the plug and strip type and patterned after the old style telegraph switchboard. It soon led to the abandonment of such apparatus in large stations.

"Almost immediately afterwards the London Exchange was started, Mr. Ormiston and Mr. Fletcher acting as engineers. About three weeks later I went to Liverpool and started the exchange there; and this was quickly followed by an exchange started in Sheffield by the late Mr. Tasker and by one in Wolverhampton. About this time Mr. Edison's representatives started the formation of exchanges in this country with, I think, the 'Fitch' form of Edison carbon transmitter and the Edison 'motograph' receiver.

"In August, 1879, a company —the Lancashire Telephonic Exchange, Limited — was formed to take over the Manchester and Liverpool exchanges; and that company subsequently, in 1881, proceeded to transfer its business to the Lancashire and Cheshire Telephone Com-

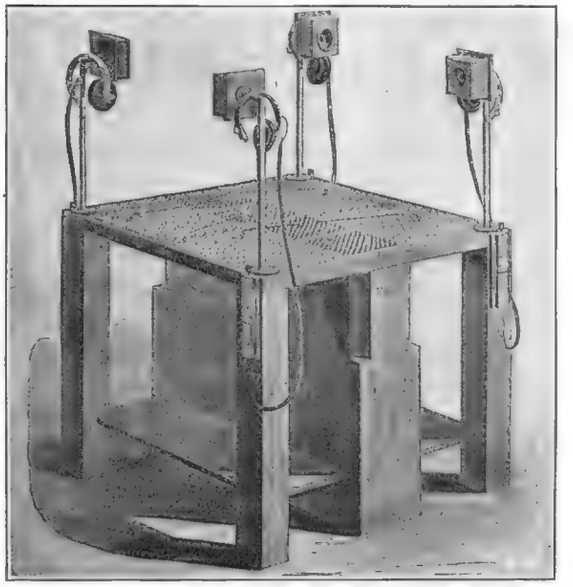


Fig. 3.—A Really Pretentious Telephone Switchboard of Early Vintage. Its Exact Age Is Not Known But It Was Among the First Attempts Made To Establish Telephone Service.

pany, Limited.

"In planning the Edinburgh Exchange I made a good many departures from previous practise. Instead of taking the lines of all our subscribers to one central station, I put up four central stations, three in different districts of Edinburgh and one in Leith, and these I fitted with the 'Jones' operating tables. This central switching apparatus differed considerably from that of the 'Williams' type used in the English exchanges. With the Jones system each operator was seated at a separate table fitted with 50 lines and arranged in such a manner that flexible connecting leads could connect any two of the tables. A very much more rapid service could be given by this means; and there was no shouting in the exchange room. I also adopted magneto call-bells for the subscribers, instead of battery call-bells as had hitherto been the practise. Some of these were constructed on the old 'thunder-pump' principle."

There is probably no other business which has advanced as speedily as the telephone system.

The appearance of a modern telephone switchboard—that of the Chelsea Central office in New York City—is shown in Fig.

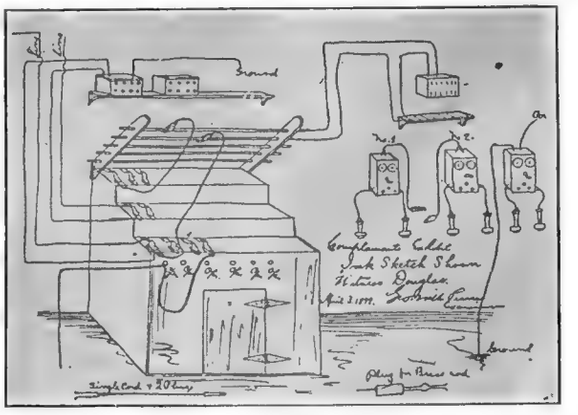


Fig. 2. Original Sketch of First Telephone Switchboard Used in Chicago, Ill., August, 1878.

4. Such an exchange handles thousands of "calls" in a single hour. Instead of requiring anywhere from 10 minutes to half an hour to complete a call—it now takes about 10 seconds.

Fig. 4. Contrast This Picture of a Modern Telephone Exchange With Those of the First Telephone Switchboards Shown on the Preceding Page. Instead of Waiting Half-An-Hour For a Call, It Is Now Put Thru In 10 Seconds.

TEACHING TELEGRAPH AND TELEPHONE AT COLLEGE OF CITY OF NEW YORK.

The College of the City of New York has establisht an evening telegraph and telephone course as an introduction to practical operating methods and commercial systems in telegraphy and telephony. There will be lectures and illustrative laboratory experiments on the following topics: General telegraph equipment, general telephone equipment, telegraph city concentration units, Atkinson repeater, magneto switchboard, coin collector telephone stations, line faults and tests, duplex telegraphy, quadruplex telegraphy, common battery telephone switchboard, artificial telephone lines and transmission tests, Wheatstone high speed telegraphy, simplex submarine cable telegraphy, terminal and outdoor construction.

The material in this course is specially chosen so as to make it of value to employes of telephone and telegraph companies who desire advancement, and who may expect to secure this by mastering something of the methods used in everyday transmission of traffic. The Western Union Telegraph Company gave all the equipment for the course and fitted up the laboratory. A large attendance is assured for these excellent courses.

PROF. BELL ON TALKING BY RADIO.

In his speech recently to the Canadian Club at St. Catharine's, Ont., Can., Dr. Alexander Graham Bell, inventor of the telephone, said:

"If the telephone has not reached its extreme limits, what next?

"I can not say what next, but I can tell you of something that happened in Washington about three weeks ago.

"The telephone has been applied to wireless, and a man in Arlington, just across the river from Washington, talked with a man on the Eiffel tower in Paris by telephone without wires.

"But that is not all. A man in Honolulu heard the conversation. From Honolulu to the Eiffel tower is 8,000 miles, one-third of the circumference of the globe. Does it mean that we can talk from any part of the world to another and without wires?"

ELECTRIFICATION IN THE CASCADES.

War burdens have failed to halt the Chicago, Milwaukee & St. Paul road in its electrification of its Cascade mountain division. Contracts, it is announced, have been awarded for locomotive and sub-station equipment at an approximate cost of $3,000,000.

The contracts call for 17 locomotives, costing about $100,000 each, and for substation equipment on the 211 miles from Othello, Wash., to Tacoma and Seattle.

The road is rushing the work to save in fuel. The electric zone now extends 440 miles from Harlowton, Mont., to Avery, Idaho.

GEORGE H. PARKMAN

of WASHINGTON, D. C.

is requested to communicate with the Editor of this publication at once in a matter that will be of great interest to him.

CARTOONING FAMOUS ELECTRICAL MEN.

IF YOU take it from the man who invented it, the telephone is a nuisance. The man who invented it, of course, is Alexander Graham Bell. And he is still a young, spry and industrious youth of seventy, full of schemes and dreams. And still, as it has been for forty years, his hour for retiring is anywhere between 2 and 4 o'clock —a. m., says the New York *Evening Mail*, accompanied by the grotesque yet novel sketches here reproduced. But about the telephone:

"My interest in it ceased," he says, "when it grew to commercial utility. It no longer needed me nor I it. In fact, I won't have one of the things near me if I can help it. They're a nuisance."

Perhaps it's a good thing we're not all inventors.

And then they tackled Thomas A. Edison, the electrical wizard of Menlo Park, who is now hard at work helping Uncle Sam to win the World War. And the signs are that he is succeeding. To resume:

When Edison was a night telegraph operator and very young, he rigged up a device that would automatically send over the wire every half hour a signal indicating he was awake and on the job when he was in fact blissfully sleeping. And he has been busy ever since.

This little device he developed into the call box, millions of which are now used the world over to keep messenger boys eternally at work. It really wasn't a very chummy invention, but then it's only one of twelve hundred or more for which he has taken out patents in the last half century, and the rest average up better.

Mr. Edison is only seventy; his grandfather lived to be 103 and his great-grandfather was 102, so he figures he has a long and busy life ahead of him.

What the Cartoonist of a Prominent New York Newspaper Thinks of Alexander Graham Bell, Father of the Telephone.

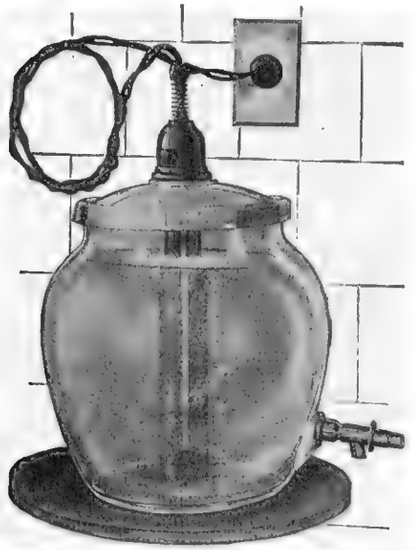
And Here's His Opinion Exprest In Pen and Ink of the Inventor of the Incandescent Lamp —Thomas A. Edison.

THE NOBEL PRIZES.

The Stockholm Academy of Science has decided not to award the Nobel Prize for physics and chemistry for the years 1916 and 1917. The prize for 1917 will be reserved until next year.

AN ELECTRIC WATER PURIFIER FOR THE HOME

Potable drinking water is rarely found. All water is either polluted, is hard, has an offensive taste, color or odor; contains organic matter or other unhealthy vegetable or mineral solids. The methods of treatment at supply stations are unreliable,



Where Water Has to Be Purified for Drinking and Cooking, the "Electrolytic" Water Purifier Does the Work; Quickly and Efficiently. It Connects with Any Lamp or Base Receptacle.

whereas the electrolytic process of sterilization possesses high efficiency and insures absolute protection.

Boiling water has become a common practise, but boiled water is not potable. Bottled waters are also extensively used, and besides being expensive they are not always safe when delivered to you.

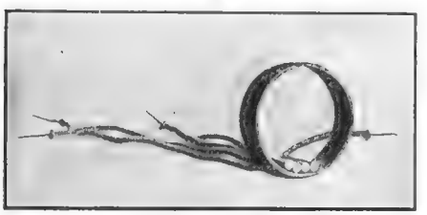
Appreciating the need of some method of rendering drinking water safe, numerous filters and sterilizers have been manufactured and sold, ranging in price from fifty cents to five hundred dollars. Filters remove some of the impurities but do not sterilize, while the Electric Water Purifier does the combined work of the high-priced sterilizer and filter and with greater efficiency, according to the publisht bacteriological tests.

A NEW SELENIUM CELL.

By R. G. Morgan.

Herewith is illustrated the latest multiple-unit selenium cell, which is of simple design, also a casing, with one soldered connection, for holding a number of these cell units.

The influence of light upon the electric current when flowing thru selenium, prop-



A New Form of Light-Sensitive or Selenium Cell. It Is Formed of Many Small Cells, All Held In a Brass Ring, Which Forms One Pole of the Circuit.

erly prepared, is well known to electricians.

The cells on the market at present are expensive and quite delicate, having a dark to light resistance ratio usually of about 10 to 1, carrying a maximum current of 20 milli-amperes.

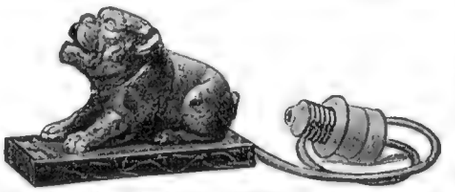
These new cells operate on a pressure of 110 volts. The maximum current that can pass without fusing the selenium is about 75 milli-amperes, at the above pressure. The dark to light resistance ratio is about 4 to 1.

A six- or eight-inch length of insulated copper wire is inserted in a piece of copper tubing, ½" by ⅛" inside diameter. The insulated wire just fits the tube, and when it is inserted the copper wire is central to the tube and lies in the tube's axis. The copper tube does not touch the bare wire at any point; 1/16" from the end of insulated wire the insulation is cut away. This end of the wire is inserted in the tube until flush with end of tube, so that there is a circular air-gap between the inner surface of the tube and the wire. This air-gap is bridged with a filling of fused selenium. Electric current cannot pass from tube to wire without flowing thru the selenium, and, as stated above, the selenium changes its electrical resistance according to the amount of light falling upon it. These unique cells are now available on the market.

Electricity is measured out by the usual house service electric meter with greater accuracy than water measured with a water meter or gas measured by a gas meter. It is immeasurably finer in accuracy than any grocer's or butcher's scales, and the average percentage of accuracy is over 95 per cent.

LET THE "ELECTRIC BULL-DOG" LIGHT YOUR CIGAR.

Those who have electric current in their homes will find this "Bull-Dog" cigar lighter an ornament and convenience at the



Novelty Electric Cigar Lighter for Home Use.

same time. It is fitted with a flexible cord and plug so that attachment to any electrolier or floor pocket is but the work of a moment. Zip, goes the button. Presto! your cigar is lighted. No mussy, smelly alcohol smudge pots to soil your clothes. or burn your hands. And the beauty of it is that it always works—no pushing an igniter trigger ten times to obtain a single light—not to mention the cussing.

A TOY ARMORED CAR.

The miniature electric armored engine here shown is a faithful copy on a small scale of those new and terrifying siege guns now being operated on specially built temporory tracks on the battlefields of Europe. The bodies of these monsters are formed out of heavy sheet steel. The die work brings out every detail of the heavy riveted plates, ventilators, doors, etc. Another realistic detail is the battleship gray enamel in which they are finished.

The revolving turret upon which two long miniature guns are mounted is a reproduction of the original. The motor is similar to those used in other miniature electric railway engines, and is powerful enough to haul any number of trail cars, which are enameled in the same battleship gray as the motor car. One of these armored trains makes a timely addition to any boy's outfit.

War Has Invaded Toyland—Here We See the Latest Miniature Electric Armored Car for the Kiddies.

ELECTRIC CURB MACHINE SUPPLIES FREE AIR TO AUTOISTS.

A new and decidedly appealing device for automobilists has recently been placed on the market by a Baltimore concern, consisting of a curb machine for distribution of free air.

New Automatic Electric Air Machine for Free Use of Autoists.

The free air machine is automatically operated day and night. The pressure dial in the upper front door is flooded with light by an electric lamp concealed inside the cabinet, and the tire valve connector on the end of the hose is so arranged that the pressure in the tire before starting to inflate is registered on the dial.

Directly over the hose rack, as shown in the illustration, is the electric switch conveniently located for starting and stopping the machine when the large dial registers the desired pressure.

It is impossible for anyone to tamper with the working parts of this free air station, for the reason that they are all contained in the upper locked compartment, even the switch controlling the large opalescent globe being locked in this compartment. This leaves nothing but the hose and starting switch in the lower compartment and, if so desired, the lower compartment can be locked and keys furnished customers.

The machine operates on either direct or alternating current. The cooling system is automatic and uses no liquid, eliminating freezing and evaporation. It has no exposed mechanism, electrical or mechanical, and is perfectly safe for even a child to operate.

ELECTRIC SPOT-WELDER SAVES TIME AND MONEY.

Electric spot welding is the process of joining or fusing together electrically two or more metal sheets or parts without any preparation of the stock used. Mechanically, it is equivalent to riveting, but it is claimed to be stronger and much quicker and more economical.

The Electric Spot Welder Here Shown Can Be Operated by Unskilled Labor and Does the Same Work As the Old-Fashioned Riveter, Faster and At a Much Lower Cost.

The process of spot welding is simple: The material is placed between the electrodes or welding points where it is desired to make the weld. Then, by applying pressure either with the hand or foot lever, the metals are prest together, electrical contact instantly made and the weld accomplisht.

Single-phase, alternating current is used in electric welding. As the voltage is reduced in the welders by a special transformer, there is no possibility of the operator receiving any shock.

Wrought iron and steel are the best materials for electric welding. Rust, scale and dry paint act as insulators and should be removed from steel before welding so that the current may flow freely. Galvanized iron can be welded, but the galvanized coating will be burnt off where the welding points touch the iron. Copper, brass and bronze welding is a trifle slower, as they are such good conductors of electricity they offer practically no resistance to the flow of current. The welding of cast iron is not recommended.

As a general rule, current cost 50% less than rivets, but the principal item which makes spot welding invaluable to sheet metal and ornamental iron manufacturers, etc., is the very large saving in labor. For instance, a large stove manufacturer installed an electric spot welder and it is now doing the work of six riveters, the current costing less than one-half that of rivets.

A general idea of the cost of operating these welders may be obtained from a statement made by a manufacturer using one of these devices: The operator welded a thousand articles per day at a cost of ten cents for power and two dollars for wages; cost to weld one article 2-10 of a cent. Before installing a welder this same firm was paying ten dollars for wages and sixty cents for rivets for riveting one thousand articles; cost of riveting one article, one and six-tenths cents.

Which goes to show by installing an electric welder this firm made a saving of one and four-tenths cents per article, or $14.00 per day on 1,000 articles.

Spot welding is acknowledged to be 75% to 100% stronger than riveting, is much faster, leaves a better finish and is far more economical, besides being perfectly noiseless.

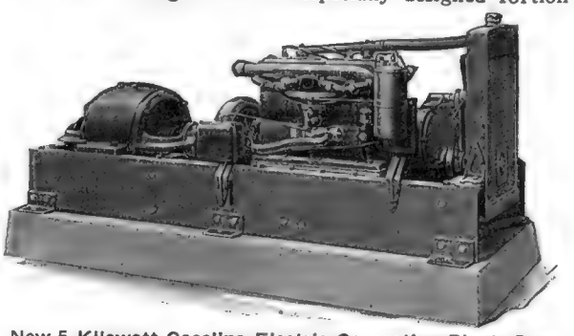
NEW 5 K. W. AUTOMATIC ELECTRIC PLANT.

To meet a constantly increasing demand for a larger size automatic electric lighting plant, an Ohio concern announces the addition of a 5 K. W. lighting plant. As shown in our illustration, this model presents an exceptionally sturdy and business-like appearance.

It furnishes current for light and power, requiring no attention beyond replenishing the supply of fuel and oil. The action is automatic thruout.

The engine is 4-cylinder, 4-cycle, and develops 20 horsepower, giving it a reserve capacity for nearly 100% overload. This, together with the fact that the set runs at the slow speed of 900 R.P.M. insures smooth, easy running, and long life.

The generator is especially designed for the work, and is directly connected to the engine thru a flexible coupling, the armature being permitted to "float" in its bearings.



New 5 Kilowatt Gasoline-Electric Generating Plant, Complete With Automatic Battery Charging Devices. The Plant Is Self-Starting.

The engine is water-cooled, the pump forcing water from a tank of large capacity thru the cylinder jackets. This heated water is then returned to the water tank after being cooled by passing thru an automobile type radiator, thru which a fan forces a stream of air.

The electrical apparatus is mounted on a neatly arranged switchboard and may be installed wherever convenient near the plant. It provides for the full automatic operation of the plant, keeping the batteries charged at all times. Any flow of battery current, either charge or discharge, is accurately measured so that the batteries are given better attention than if used on a hand operated plant. For starting, current is taken from the battery and the generator is temporarily a motor until the engine starts firing. The plant is so arranged that the engine starts and recharges the batteries when they are 25% discharged. Thus the battery is never allowed to drop below 75% of full charge capacity, "sulfating" of the plants is prevented, and long life of the batteries is assured.

THE "GALVANOSET" — A NEW ELECTRO-MEDICAL APPARATUS.

One of the great problems always confronting the electro-medical practitioner has been how best to safely apply currents derived from the ordinary lighting mains.

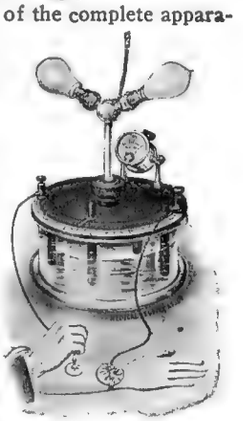
With this new English make of apparatus one utilizes the main supply of electricity by attaching it to any electric light socket by a standard attachment which can be quickly connected when required.

The current is then conducted thru two suitable resistances into a vessel of water by means of two electrically indestructible electrodes, which are placed on opposite sides of the vessel. At right angles to these two electrodes a second pair of electrodes is placed in the water; *these are connected to the patient.* As long as the two electrodes, which we will call "Patient" electrodes, remain at right angles to the two electrodes, which we will call "Supply" electrodes, no current will be obtained, as the electrical potential in this position will be zero. The supply terminals are mounted on a disc of vulcanite, arranged so that it is free to rotate over a graduated celluloid scale. If this disc is now rotated from its right angle or zero position, any desired current can be obtained from minimum to maximum by the most gradual increase. If it is desired to reverse the polarity of the current leading to the patient, the disc is brought back to its zero right angle position and then rotated in the opposite direction.

A current giving every degree of variation from 0 to 500 milliamperes and at a voltage from zero to the maximum required, and absolutely safe under all circumstances, is readily obtainable. This apparatus has great advantages over wire rheostats. The disadvantage of wire rheostats is that they are apt to break and give the patient a severe shock. Again, with the wire rheostat the patient is always connected to one pole of the supply, and if by accident the patient gets into connection with the opposite pole, he is then in direct connection with the main supply.

With this apparatus it is impossible for the patient to get into direct contact with either the positive or negative side of the supply.

The weight of the complete apparatus is seven pounds, so it can very conveniently be taken to a patient's house. A dead-beat D'Arsonval milliamperemeter, with shunt winding, records the current passing to the patient. This is mounted on the apparatus in a convenient position, and is permanently connected in the circuit.

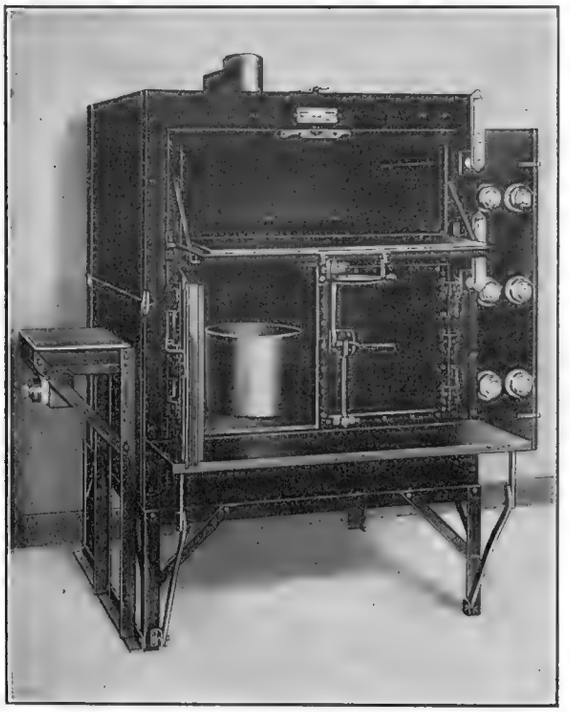


Unique Electro-Medical Current Regulator.

The construction of this device is extremely simple, yet sturdy and efficient.

A NEW ELECTRIC ARMY OVEN.

A new method of cooking is rapidly becoming popular. It is in the combination electric oven which is designed for all kinds of cooking; Boiling, Roasting, Baking, etc.



A New Electric Oven Designed for Use by Uncle Sam's Soldier Boys. It Is Rated at 15 Kilowatts and Has Several Separate Compartments Provided With Three-Heat Switches. The Hot-Plate at the Left Is Used to Heat a Coffee-Urn.

One of these large electric ovens designed for use by the U. S. army is illustrated here.

There are many advantages in this system of cookery. First, the use of such a combination oven eliminates the necessity of a range—as it handles all the heavy cooking. Short orders and any small emergency cooking can be done on a hot plate—which is much more economical than maintaining a fire in a big stove. Secondly, it conserves heat, kitchen space and time—and saves the heating of one, two and oft-times three cooking devices.

Foods boiled this way are more evenly. and thoroly cooked because the constant, uniform heat penetrates *all* sides of the vessel at the same time. Thru the heavily-insulated walls and the closely-fitting doors of the oven, there is no air circulation to carry off the flavors and juices of baking and roasting meats.

Moreover, the great saving in meat shrinkage is an important factor and there are a number of restaurant owners who have estimated that it more than pays their entire electric bill which includes ovens, lights, coffee urn heaters, etc. Another feature is the efficient utilization of the heat. Thru the heat-conserving properties of the oven, oat meal and other cooked cereal, baked apples, pork and beans, etc., can be placed in it after the current is off and the day's work finished—and be thoroly cooked next morning by the slowly receding heat.

The fireless cooker construction eliminates the air currents and this feature in turn eliminates the interchange of odor and the impregnation of the flavor of one food with that of another.

An electric hot plate is mounted externally on one side of the oven on which the coffee urn rests. The oven has the following compartments: Lower compartment has swing-type doors which can be opened independently of each other. The upper compartment has the drop-type door. Swing-type door has outside shelf. Compartments are separate—making it possible to heat only one when a limited amount of cooking is to be done. Has three heating elements—one under each deck and one at the top of the upper compartment. Each element is operated by a three-heat switch. Two mercury thermometers are fitted on the oven. The oven has a maximum consumption of 15 kilowatts. It weighs approximately 1,500 pounds.

NEW ALTERNATING CURRENT SOUNDER.

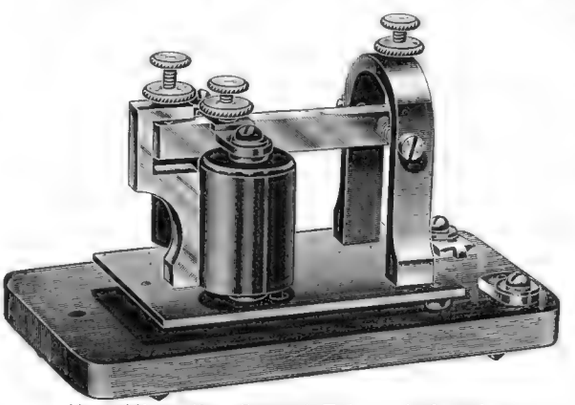
The illustration shows a practical alternating current sounder, the principle of which is so simple that it is a wonder it was not discovered long ago. It was invented by Mr. J. J. Ghegan.

The instrument is the same size as the regular local sounder which it resembles in general appearance, the only change being in the position of the magnet spools and the construction of the armature. It can be used on any 110-volt, 60-cycle alternating current circuit either in series with a lamp or thru the secondary of a small step-down transformer. The transformer method is preferable, as with it the local wiring may be of the ordinary kind used in local battery work, and one transformer can furnish current for several sounders.

The instrument can also be operated on the 110-volt circuit without either lamp or transformer, when specially wound for such use.

Altho the current required to operate the sounder in the ordinary way, thru the front contact of a relay, is very small, it can be arranged to work thru the back stop so that current would be used only when the sounder might be working.

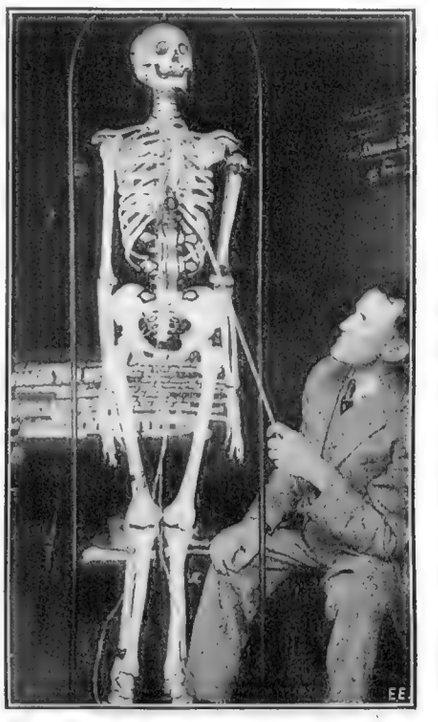
This sounder will work on direct current without any change of adjustment, so that in places where there is a liability of interruption to the alternating current lighting circuit, two dry cells could be switched in to bridge over any such interruptions.



New Alternating Current Telegraph Sounder.

A LIVELY ELECTRIC SKELETON.

Dr. Ratledge, of Los Angeles, has a novel idea of explaining a method of healing or manipulating the spine. He has fastened a skeleton so that it hangs in a frame made from pipe. Electric lights are placed where the different vital organs were once located. Small lights are placed in the eye-sockets, and long tubular lights are placed on the arms and legs.



A California Doctor Has Devised an Electric Skeleton with Which He Clearly Demonstrates, by Flashing Different Lights About the Limbs, the Action of the Spine and It's Nerves.

Along the spine at the point where the nerves lead off to the various vital organs there are placed electric switches which connect with the various lights. To illustrate what happens to the vital organs when the nerves leading from the spine become pinched or otherwise injured, the instructor turns the switch leading to any particular organ, which instantly dims the light supposed to represent the particular vital organ, such as the heart, lungs, etc. This is supposed to illustrate the manner in which the force flowing to the vital organs is shut off when the nerve is obstructed. To show what happens when the nerve is cut or otherwise becomes unable to transmit the nervous energy, he turns the switch off, causing that particular light to go out, illustrating how a vital organ becomes incapable of performing its work when shut off entirely.

Contributed by G. W. GEIGER.

PRINTING TELEGRAPH ON LACKAWANNA RAILROAD.

The Lackawanna Railroad Company has installed and put into operation two printing telegraph instruments between the offices of the traffic manager, located in New York, and the car service superintendent in Scranton, Pa., a distance of 150 miles. These instruments are used in connection with the freight clearing house system recently adopted by the Lackawanna Railroad. This printing system is proving very successful.

How Jimmy Saved the Troop Train

By JOHN T. DWYER

Showing How Quick-Witted "Jimmy" Hanlon Thought of the Right Idea at the Critical Moment and Thereby Earned the Gratitude of the War Department

"I WONDER how Jack made out with his examination," mused Jimmy Hanlon, as he sat at his key in the dispatcher's office of Winslow station. "Seems to me he ought to pass easily enough. Well, I should know pretty soon, for here comes the rascal now or I'm greatly mistaken. But Lord! he sure is making enough noise."

Bang! went the lower outside door of the station and the resulting vibration sent a tremor thru the whole building. Then a clattering of hasty footsteps and finally the office door swung on its hinges, revealing the puffing and panting Jack Godfrey, who generally acted as night shift for Jimmy.

For a few seconds he stood there trying to get his breath, and then blurted out:

"Congratulate me, old boy! I've come out with colors flying! And what do you think? They actually gave me a rating. From now on I'm Corporal Godfrey of the Signal Corps, if you please."

"Whew! you don't say so!" ejaculated Jimmy. "Why pretty soon you will be a General or something, and then I'll bet you won't want to look at your friends any more."

"Nix, Jimmy, you know I'm not that kind, altho to tell the truth, it does make me feel a little tighter around the vest to realize that I'm to wear *chevrons*. But say, I wish you would reconsider your decision and join with me," continued Jack more seriously. "We've been chums so long now that it will go kind of hard to separate. Come, can't you manage it somehow?"

"No, Jack," replied Jimmy soberly. "You know there are others depending on me and it wouldn't be fair to them. But," and his eyes lighted up with enthusiasm, "you may be sure that if I had 'no entangling alliances,' as Washington might say, I'd be there in a jiffy. Never mind," he continued, "I'm a good deal like Micawber and will hope for something to turn up, which will enable me to take my place beside my old friend."

Further conversation for the time being was interrupted by the sudden sounding of the instrument and Jimmy turned to give it his attention.

"That's interesting," he said, after getting the news. "Harris at Edgeville states that a special train loaded with a regiment or so of infantry has just gone thru there on the way to the coast from where the boys will embark for France. No doubt, she'll pass by here in another half hour or so. Seems to me, it would be a good idea for the people of Winslow to give them a rousing greeting and send-off."

"Not much chance," Jack replied rather scornfully. "In the first place, there are too many rabid pro-Germans in this burg. Why, really I wouldn't be at all surprised if some of these hot-headed Dutchmen tried to wreck it."

"Nonsense! Jack—the kind we have here are of the harmless variety. Besides, there are still a number of true Americans in this town that would make short work of them if they tried any such low-down stunt."

"Well," he added rather abruptly, "here I am talking like a 1905 model Edison phonograph, when I should be on the road for home. So, you had better take charge

" . . . Young Man," Spoke Up One of the Officers, Whose Eagle Insignia Showed Him To Be the Colonel In Command, "What You Have Done I Consider To Be the Cleverest Bit of Ingenuity That I Have Come Across In a Long While. . . . Such Work as You Have Performed To-night Will Not Go Unrewarded. . . . You Have Saved the Lives of at Least One Thousand of the Nation's Fighters."

of the fort, General, or rather Corporal, until morning. Good night! and don't let any German plots worry you in the meantime."

"Good night!" responded his chum cheerily.

The fact that it was growing dark and that Jimmy lived about three miles outside the town prompted him to take as short a cut as possible, and so it was he decided to go by way of the railroad. This would shorten the distance considerably and, at the same time, enable him to reach home before supper.

He had gone but a little ways, when as usual with one of his mental temperament, he soon fell into a deep study over the events of the day, especially as regarded his friend's enlistment and his own misfortune in not being able to join.

"I don't know what I'll do when Jack is called," he mused rather sadly. "He's always been such a good scout that it will go hard to lose him even for awhile, and then again, perhaps, it may be forever." This latter pessimistic thought he put away from his mind, as he did not like to entertain any such fate for one who had been his constant companion since boyhood. "Yes," he continued, "I sure will miss him. In my mind, Sherman didn't say half enough about the virtues of war."

Jimmy had been so intent on his own mental retrospections that he failed to notice the silhouettes of three figures standing along the track about twenty-five yards ahead of him. They, on the other hand, were equally oblivious of the proximity of another, which was due mainly to the fact that they were busily engaged in conversation.

At first, the three spoke in low tones but gradually, as their confidence increased in the belief that there could be no one to hear them at such a time and place, they became less cautious in controlling their voices, with the result that Jimmy was soon rudely awakened from his reverie by the sounds.

His interest and curiosity aroused, he resolved to be a silent party to their animated conversation. While, at first somewhat scrupulous on the point of acting as an evesdropper, he put aside his conscience by arguing that perhaps something might be wrong, after all. "It certainly does look queer," he admitted to himself. As he was about to move closer so as to catch the topic of their conversation, one of them struck a match, evidently in order to light a cigarette, and the resulting illumination enabled Jimmy to secure a look at their faces. To his surprise, he recognized at once the features of one of them as Fritz Schuster, the town butcher, who was notorious for his rabid pro-German leanings, which had taken expression several times in an abusive denunciation of America for waging war against the Fatherland.

Jimmy's curiosity at once gave way to suspicion, for to him it seemed very significant indeed that one so firmly antagonistic to the country should be found at such a place; the more so, when taking into consideration the fact that the troop train would be due in a few minutes. Whatever doubts he might have had as to the grounds for his suspicions were immediately dispelled by hearing the conversation that followed:

"I tell you, Fritz," spoke up the rather tall one, who appeared to be a German secret service agent, "that was a clever idea of yours to place the 'nitro' on the tracks running alongside the bluff. When she explodes, the train will not only be blown off the rails, but ditched as well, and down a hundred foot embankment at that. In my opinion," he added grimly, "there will be no survivors."

"Jah!" answered Fritz, in a little broken English, "so mouch the better! I chust lof them Americans! Vell, dis will be two thousand less for the dear *Vaterland* to fight. Maybe," he continued with a show of pride and vanity, "maybe the Kaiser giff me un iron cross, chess? Ain't dot so?"

"Most certainly he will," spoke up the third and shorter man who seemed to be the one in authority, "for if this job turns out right, I intend to bring the matter to the attention of the Imperial Government. Germany always takes care of those who serve her interests."

Jimmy waited to hear no more. He had listened long enough to convince himself that the troop train was in peril. There remained but one thought in his mind and that was to save it either by removing the dangerous explosive or else warning it in time of the menace. With Jimmy, "to think was to act" and so, swiftly and silently, he beat a detour around the conspirators to avoid being detected by them. Now, it was about three-quarters of a mile to the spot where the explosive had been placed, so he figured that by pushing himself to the utmost, he could cover the distance in time. Bracing himself for a moment, he exerted all his strength and then leaped forward.

The race with Death had begun!

Now it was that his old training practise came into good use. Swiftly he sped by the trestles until they fairly seemed to fly past him. One hundred! two hundred! three hundred yards!—still more than a half mile to go. Manfully, he tried to keep up the same pace but the strain was too great and he gradually slackened. And no wonder! His legs now seemed to weigh tons so that it took excessive effort to force them ahead and his breath came in quick short gasps. The "man" in him, however, would not quit, but urged him to renewed exertion.

"Oh, Lord give me strength. Two thousand lives!" he murmured again and again. If he could only hold out for a little longer, the race would be won and Death cheated of its prey.

Then it happened. A thud against something hard and the next moment Jimmy was sent hurling to the ground. Stunned by the suddenness of it all, he did not arise at once but lay prone for a few seconds. Almost immediately, however, he sought to get to his feet, but the effort caused such an agony of pain that he sank back again to the ground. His right foot and ankle had received a serious sprain in falling over an iron hand bar which had tript him. The pain was excruciating but not enough to drive from his mind the troop train, the whistle of which, even at that moment, sounded in his ears.

"My God! it's coming and I am helpless to save it! Oh, if only there were some way to signal the danger."

That word "signal" brought the big idea to Jimmy, for like a flash, there past thru his mind a plan as simple as it was practical and he at once lost no time in putting it to the test.

It was this: Only recently, the railroad for which Jimmy worked as operator, had installed a new electric Block System for a distance of about two miles on either side of the town, with the blocks about a mile apart. This system was of the "normal safety" type and the semaphores at the entrance of each so called "block" were kept normally in an upright position of "clear" by means of a local motor and relay, operated in turn by the normally closed track circuit. As long as the block remained open, that is, not obstructed by a train ahead, the semaphore would remain in the "clear" position, but as soon as a train entered the same, then the rail current would be short-circuited via the axel and wheels of its locomotive, thus depriving the local relay of current. This being so, the semaphore naturally would obey the laws of gravity and fall to a horizontal position of "danger." Should another train then come, it would be in a position to know just what the condition of the track ahead was, and stop accordingly.

Fortunately, from the description unwittingly disclosed during the conversation of the conspirators, Jimmy surmised that the explosive must have been placed about fifty yards within the entrance of the block, so if there could be found something to provide a "shunt" across the track circuit, the semaphore could be dropt and thus the oncoming train warned of the danger ahead.

Feverishly, he searched his pockets for some pieces of loose wire but without success. Something must be done and done quickly, for already he could perceive the train as it took the curve two hundred yards or so before the block entrance.

"Why, the very thing!" he cried aloud. Notwithstanding the intense suffering caused by the movement he crawled over to the track and picked up the iron bar which had caused him to fall. A few short seconds and it was placed directly across the rails of the track in such a way as to bring about a complete "shortcircuit" of the electric current.

(*Continued on page* 733)

The "March" Electrical Experimenter

We have in preparation a great variety of subjects for the "March" issue of the ELECTRICAL EXPERIMENTER. *We are sure that you will enjoy every one of them and moreover find them both entertaining as well as highly instructive. A great many people complain now and then because we publish articles which seem mere "theories." Perhaps so—but you can rest assured that these special articles, often illustrated at great expense by elaborate wash drawings, possess a new basic feature: something which will invariably visit us in daily life before a great while. Past experience has proven this many times over. Such an article appears on page 661 of this issue describing a radically new principle in talking machines—the 48 record "Orchestra Phonograph." It's new—it's interesting—it's instructive! Read it and learn something.*

For the March issue:

"At War With the Invisible"—A gripping story, well told and with a thoroly scientific atmosphere, by R. and J. Winthrop.

"Arlington via the Talo Club"—An amusing account of a visit to the King of all Radio Stations, by W. J. Howell.

"Wireless on the Submarine"—A topic of universal interest. Explains how the U-boat flashes messages a thousand miles or more.

"The First Trolley"—With interesting photos, by George Holmes.

"Experimental Physics"—Lesson 11, by John J. Furia, A.B., M.A.

How to Make a Water Jet Vacuum Pump—by Prof. H. E. Metcalf.

Telegraphing thru the Earth—of interest to all "Radio-bugs."—By Roy T. Griffith.

Siphons—How they work, by F. W. Russell and J. L. Clifford.

Wavemeters—Their uses and Construction—by M. W. Sterns.

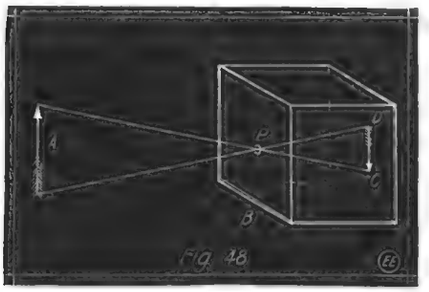
Experimental Physics

By

JOHN J. FURIA, A. B., M. A. (Columbia University)

LESSON 10.*
Photography.

IN lessons 8 and 9 we discust the formation of images by mirrors and lenses and noticed that it was quite easy to "catch" the image of an object thru a lense. If the screen on which the image is caught is sensitized so that it will retain the image after the object has

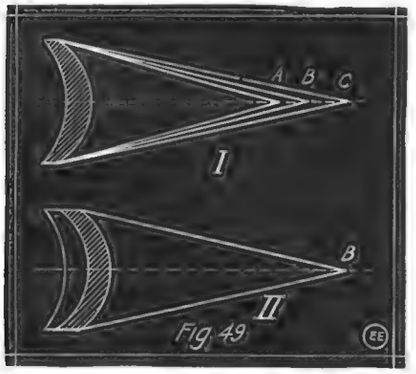


Illustrating the Principle of the "Pin-hole" Camera. The Object Is Reversed on the Screen as Indicated at D-C. One of the First Cameras.

been removed, we have a *photograph.* In this lesson we shall take up in detail the formation of the image on the screen (photographic plate or film) and the next lesson will be devoted to the retaining of the image.

EXPERIMENT 55—

The simplest form of the camera (the *pin-hole* camera) can be easily constructed and used successfully (see figure 48). Secure or make a light-tight box about 6 inches on a side, and punch a pin-hole thru the center of one side. We shall call this side the *front* and the side behind it the *back.* The back should be hinged so that a photographic plate can be inserted. Let "A" represent a tree or some other object. Then light from the top of "A" will pass thru pin-hold "P" to point "C" on the back, while light from the bottom of "A" will pass to the point "D" (above "C"), illustrating the principle that light travels in straight lines. If a room be darkened and light from a bright object be permitted to come in thru a pin-hole an inverted image will be formed on the wall of the room just as in our pin-hole camera, and a picture can be taken. It is important to note that a clear image is formed despite the fact that no lens has been used.

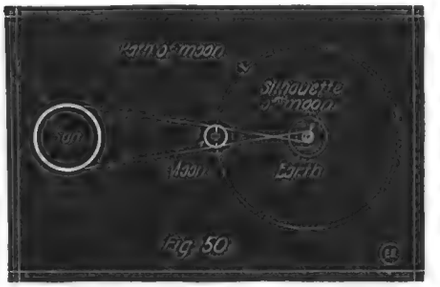


The Difference Between the Focal Point of a Simple Lens (I) and the Achromatic Lens (II).

The writer has made good pictures of outdoor scenes with a pin-hole camera

Continued from Nov., 1917, issue

giving an exposure of about three minutes. Naturally it would be quite inconvenient to have to wait so long for each exposure, and one would have to limit oneself to taking pictures of still life, so that for practical purposes we use a lense in place of a pin-hole which gives us a sharp image and at the same time lets in a great deal of light hence permitting a short exposure. From the discussion in the last lesson it is apparent that the convex lens is the type to be used, and also since the image is sharp only when "focused" the back or front of the camera must be movable so that the distance between the lens and screen (ground glass or plate) can be changed as required. If F represents the focal length of the lens (found by the method explained in lesson 9) and I and 0 represent the distances of the image and the object, respectively, then $1/F = 1/I + 1/0$ is the formula from which any one of the quantities can be computed if the other two quantities are known. Hence by use of this formula the maker of the camera is able to furnish a scale showing just where to set the camera so that an object a certain distance away will be in focus.



The Principle of the "Silhouette"—A Partial Eclipse Is Caused by the Moon Getting Between the Sun and Earth, Casting a Shadow or Silhouette on the Earth.

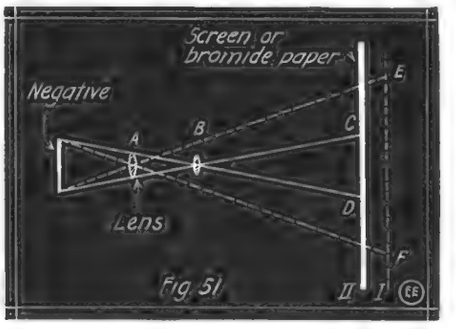
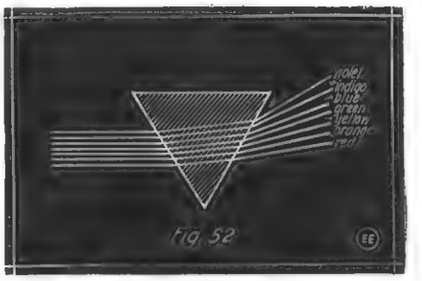


Diagram Showing How, When Light Is Past Thru a Photo Negative, the Image Can be Enlarged by a Lens "A," and Thrown on a Screen at E-F.

EXPERIMENT 56—

If a strong light is focused thru a lens on a white screen it will be found that the actual focal point will be difficult to find. A point "A" will be found which seems in focus, but which gives a violet tinge to the image. (See Fig. 49.)

Another point "C" will be found giving an image with a reddish tinge and other points in between of various tinges. This dispersing of the different colored rays (to be treated on in detail later) so that the different colors do not focus at the same point, is corrected by the use of the achromatic lens. The rays which act on the sensitive surface of the plate or film are those from the violet end and are called *actinic* or *chemical rays.* The visual rays are from the red end. Hence if these rays are separated by the lens the image formed on the screen is not the one which will make the picture. However, flint and



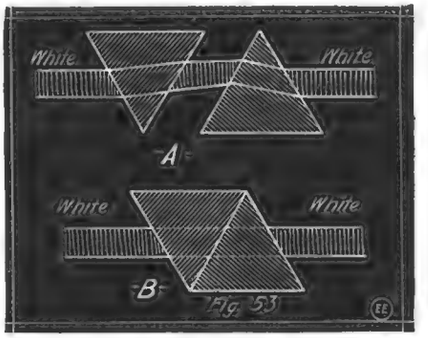
How a Prism Breaks Up a Beam of White Light Into Its Component Colors, as Shown at the Right.

crown glass have different dispersive powers, and, therefore, one can be made to correct the action of the other. Flint glass bends the chemical rays more than does crown glass, and so by combining a negative lens of flint with a positive of crown glass the chemical and visual rays are brought to focus at the same point. In the case of small cameras dispersion (chromatic abberation) is so slight that it is not necessary to use the achromatic lens.

DIAFRAM OR STOPS.—The best part of a lense is its center since the light passing thru the center is correctly refracted as in the case of the pin hole. Hence the smaller the lens opening (diafram stop) the sharper the picture but the greater the time required for the exposure. The fast lenses are lenses which will focus sharply even when the diafram is open at a large stop, thus letting in a large amount of light and permitting a short exposure.

EXPERIMENT 57—

To make a silhouette of a person or object take the picture with the camera facing the illuminating source (the sun for snapshots) and the object or person in between the camera and the illuminating source. The result on the ground glass will be a shadow of the person or object, and the picture of this shadow will be a *silhouette.* It should be noted here that a partial eclipse is really nothing but the passing of a silhouette over the earth (see Fig. 50).



If White Light Is Past Thru Two Prisms, the Result Is White Light, Since the Rays Bent Up by the First Prism Are Bent Down by the Second Prism.

(*Continued on page* 715)

The Home-Treatment of Tuberculosis by High-Frequency Currents

By DR. FREDERICK FINCH STRONG

Lecturer in Electrotherapeutics, Tufts College, Boston

STATISTICS show that one death in every seven is caused by tuberculosis, usually in the form called "Pulmonary tuberculosis," "Tuberculosis of the Lungs" or "Consumption." Sanitary regulations, isolation of cases and hygienic education are rapidly lowering this high death rate, but tuberculosis is still humanity's most terrible scourge.

Thruout the ages "The Great White Plague" has done more to retard human progress than all the wars of the centuries —not excepting the present Armageddon.

Fortunes have been spent in the study of the prevention and cure of this disease; countless fortunes have been made by quacks and mistaken enthusiasts who either claimed or believed themselves to have discovered "A Sure Cure for Consumption." The discovery of tuberculin by Koch was widely heralded as the longed-for panacea, but it proved a failure, and up to the present time no "specific" has been found for the cure of tuberculosis.

The importance of the subject is further emphasized when we reflect that even when it does not manifest as consumption, tuberculosis still does its insidious work in undermining the stamina of the entire race. Dr. A. C. Geyser states that "ninety per cent of all children are infected before their twelfth year, and nearly all bodies that come to autopsy show unmistakable signs of previously existing tubercular lesions." That more people do not develop the disease in its active form is due to the natural curative forces that are always at work in the human body.

Disease germs grow only in a suitable soil or medium; healthy human tissues do not furnish this medium. Only when these tissues are weak, inactive or charged with dead matter do they allow disease germs to multiply in their midst and produce their poisonous secretions.

In a previous article in the March, 1917, EXPERIMENTER—"Electricity and Life"—the writer called attention to the existence of the "Vital-force," or "Prana," thru the activity of which all life is maintained. This is absorbed from the food, air and water, and is probably distributed by a circulating system all its own—a subtle "Etheric Body" which interpenetrates the coarser molecules of the organism and is doubtless formed of imponderable chemical atoms finer than the gas atom and coarser than the electron. Just as modern physicists find it necessary to employ the hypothesis of "The Ether of Space" in order to account for the phenomena of radiant energy, so the most advanced of our physiologists and biologists are assuming the existence of the "Etheric Body" in order to explain the phenomena of life in animal and vegetable bodies.

Portable Yet Effective Electrical Apparatus for Diathering and Tesla Treatment of Tuberculosis.

Probably the great sympathetic nervous system distributes the life-carrying matter of the etheric body in much the same way as the heart and blood vessels transmit food and oxygen to the cells and tissues. The latter circulation depends upon the maintenance of the former, for if pressure is made over certain nerve centers the blood stream is retarded or ceases altogether; pressure on another center stops the breathing mechanism and death from syncope follows. Great discoveries will be made in the immediate future thru the study of the nerve currents and their relation to the Etheric Body and to "Vital Force."

It is because this vital circulation is fairly active in the majority of persons that so many recover spontaneously from pulmonary tuberculosis. But in cases of weak "vital resistance," where the Prana is not actively distributed to the lung cells, the tubercular germs grow, multiply, secrete poisons and ultimately make the physical body unfit for its human tenant who is forced to move elsewhere!

This lowered cell vitality results from hereditary weakness, improper food, and above all, from insufficient fresh air and out-of-door exercise. We can prevent this hereditary weakness in future generations by following Eugenic principles and exercising the same care that we now use in breeding blooded cattle and horses.

But meanwhile we have in our midst countless thousands of poor sufferers in whom tuberculosis exists in an active form, and the majority of whom face a lingering death scarcely less horrible than that resulting from the "poison gas" of the war zone. What can we do for these unfortunates? Those of them who can go to the special tuberculosis sanitariums and have daily treatment under proper surroundings stand a fair chance of recovery, especially when the disease is in the early stages. There are hundreds, however, who cannot go to such institutions.

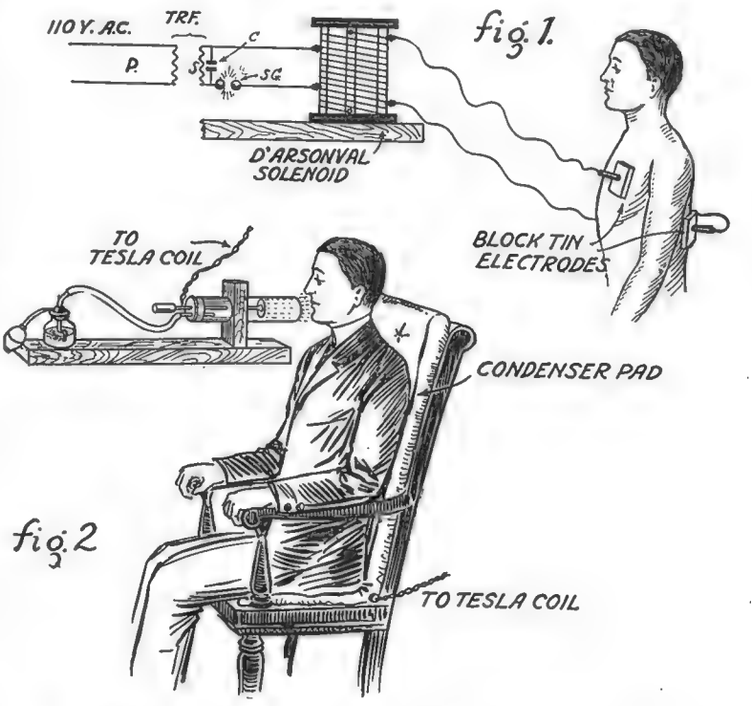
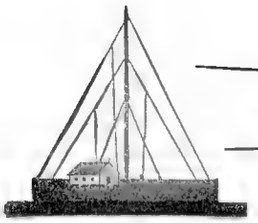


Fig. 1 Shows Treatment of Tuberculosis by "Diathering," Fig. 2, Treating Tuberculosis by "Ozone Nebula" and Tesla Currents.

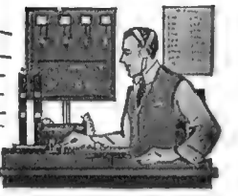
When we do not use a machine it rusts and falls to pieces; when we do not use an organ or tissue of the human body the life-force and blood supply are diminished and we have a condition where disease germs can find a ready foothold. If certain parts of the lung are not periodically expanded by the inspired air they become "Anaemic" and susceptible to tubercular infection, which afterwards spreads to other parts of the lung. Now if we can find a way of revitalizing these anaemic areas, nature will use the blood and oxygen to start a regenerative process and the bacilli and dead cells will be thrown off in the expectoration. This latter material—the "tubercular sputum"—carries the infection to others; it should always be burned or received in vessels containing antiseptics such as creolin or sulphonaphthol. If this were always done the disease would soon be stamped out.

It is a well known fact that high-frequency currents when past thru the body cause every molecule to vibrate to their particular periodicity, and this vibration produces secondary effects, notably the release of heat in the tissues and the increase of local blood supply. When an acute infection occurs in any part of the

(*Continued on page* 718)



RADIO DEPARTMENT



Notice to All Radio Readers

As most of our radio readers are undoubtedly aware, the U. S. Government has decided that all Amateur Wireless Stations, whether licensed or unlicensed, or equipt for receiving or transmitting, shall be closed.

This is a very important consideration, especially to those who are readers of THE ELECTRICAL EXPERIMENTER, *for the reason that we desire to continue to publish valuable articles on the wireless art from time to time, and which may treat on both transmitting and receiving apparatus. In the first place, there are a great many students among our readers who will demand and expect a continuation of the usual class of Radio subjects, which we have publisht in the past four years, and secondly, there will be hundreds and even thousands of new radio pupils in the various naval and civilian schools thruout the country, who will be benefited by up-to-date wireless articles treating on both the transmitting as well as receiving equipment. Remember that you must not connect up radio apparatus to any form of antenna.—The Editors.*

How New York Police Use Radio

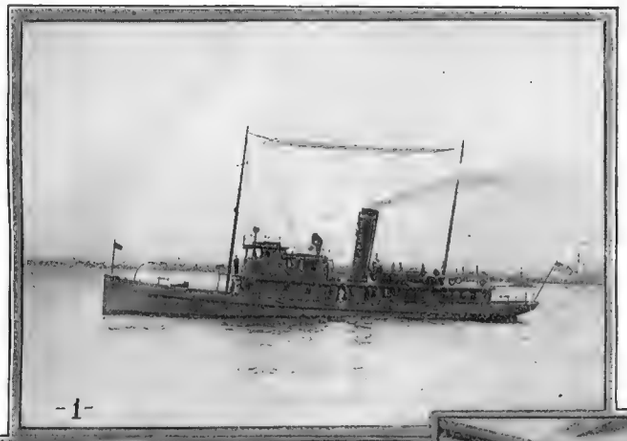
IN the programme of general preparedness instituted by the Police Department of New York City, wireless telegraphy was adopted early in 1916 by Commissioner Woods, as an added means of communication between the different divisions of the Force. As such it is the first instance on record where wireless telegraphy has been brought into use in a municipal department in the world.

Altho the Police Department already had a large private telephone system, the necessity of a dependable means of communication in addition, was realized. Considerable work was done with signal flag and Morse "blinker" light system, and also with portable field telephones, but wireless telegraphy has received the most attention to these various auxiliaries.

In introducing this part of his plan for police preparedness, Commissioner Woods first establisht a school of instruction in radio work at headquarters, one of the class rooms of the Training School being fitted up with a buzzer system for code practise and with blackboards for demonstration work and circuit diagrams. Sergeant Charles E. Pearce, a member of the uniformed force and a former telegrapher, who has been studying and experimenting with wireless in his spare time for several years, was given charge of the school, and thirty of the members of the department who had had experience in telegraph, telephone or signal work were assigned for the course of study. On completion of the course all past the Federal examination and received licenses as first class radio operators.

High grade commercial wireless equipments were then installed in the headquarters buildings in Manhattan and Brooklyn, and also on the Department steamer "Patrol." This ship is the flag-ship of the

(*Continued on page* 716)



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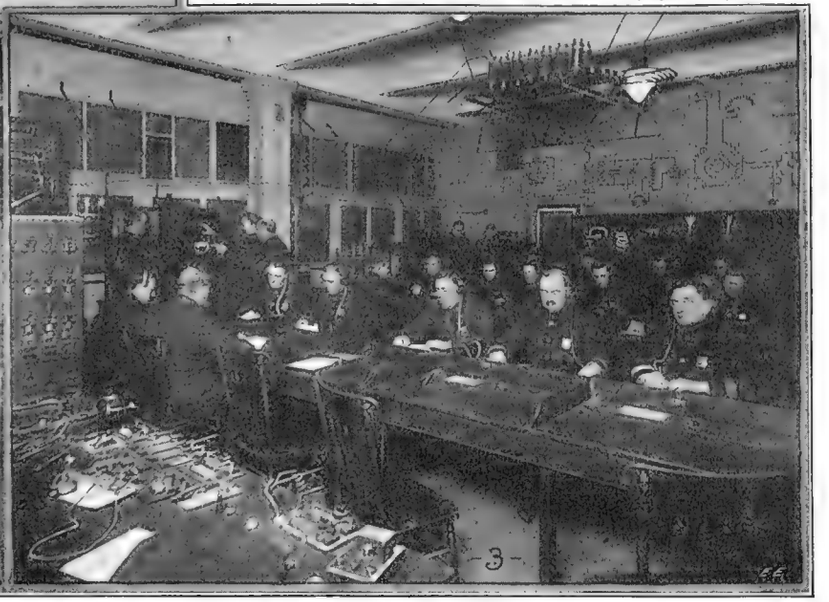

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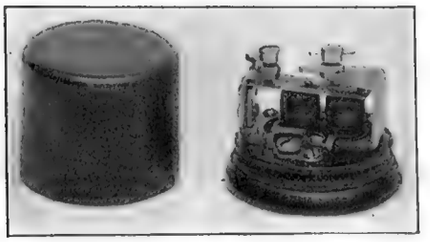
Fig. 1. The New York Police Boat "Patrol," Fitted with Radio and of Inestimable Service To the Harbor Department. Fig. 2. Interior of Radio Cabin On the "Patrol." Fig. 3. Some of New York's "Finest" Being Taught the Radio Code and Method of Handling the Apparatus.

NEW RADIO BUZZER AND BLINKER KEY.

The new hy-tone radio buzzer here illustrated was designed by a New York radio engineer, Mr. Louis G. Pacent. It is fitted with locking attachments that lock the adjustments after the proper pitch or note is obtained. Once locked the adjustments will not loosen and the note or tone will remain steady until the user wishes to obtain another note.



New Hy-tone Radio Buzzer for Learning the Code and Other Purposes. Has a True 500 Cycle Note, and Tone Is Adjustable.

The common adjusting screw, or the one which is mostly used, is made into a miniature vise; this permits the user to make the necessary adjustments without the use of tools of any description. The special adjusting screw is provided with a slot and needs to be adjusted only in special cases where a larger difference of tone is desired. These buzzers are supplied with this screw adjusted so that the user can easily do his own adjusting with the common screw, for the clear tone mostly used—namely 500 cycles or 1,000 sparks per second.

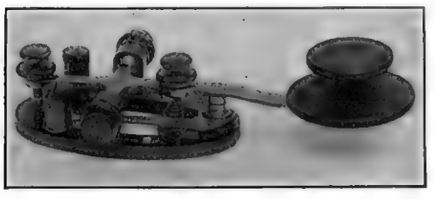
The base is of Bakelite-Dilecto, an insulating material which affords small losses, will stand any climate and is past by the United States Navy Department. Special hard silver contacts are used which wear evenly and a clear, persistent tone is obtained. The cap is of brass, black enameled and is fastened to the base by a bayonet socket.

The hy-tone radio buzzer has been approved by the United States Navy Department Bureau of Steam Engineering.

It will prove extremely useful for exciting wave meters, inductance bridges, etc., and is ideal for learning the code in conjunction with a telephone receiver.

The "blinker key" is made in conformity with the specifications of the United States Navy Department, and is equipt with Navy standard contacts, which are of sterling silver, ¼ inch in diameter. The key was designed by Mr. Pacent also, and several other models similar to it have been designed for handling heavy radio transformer currents.

These contacts are interchangeable and can be readily replaced when necessary. The lower contact can be removed without disturbing the insulation or fitting holding



Improved Blinker and Radio Key for Handling 110 Volt Currents. Fitted With Shockproof Knob and Heavy Silver Contacts.

it in place so that it is not necessary to remove the key from the base.

A special phosphor bronze current carrying spring is fastened on the base and lever so that the current is carried by this spring and not by the trunnion screws.

The trunnion standards are tapt and threaded to take a bushing which is also tapt but threaded at one end only. The unthreaded ends take the lever trunnions. The bushing is for making the coarse adjustments which are made permanent by means of lock nuts. The threaded end of each bushing is fitted with screw and lock nut making and securing fine adjustments. The advantage of this double adjustment, secured by employing adjustable bushings, prevents the ejectment of the key trunnions from the trunnion sockets and also permits of severe usage without impairment.

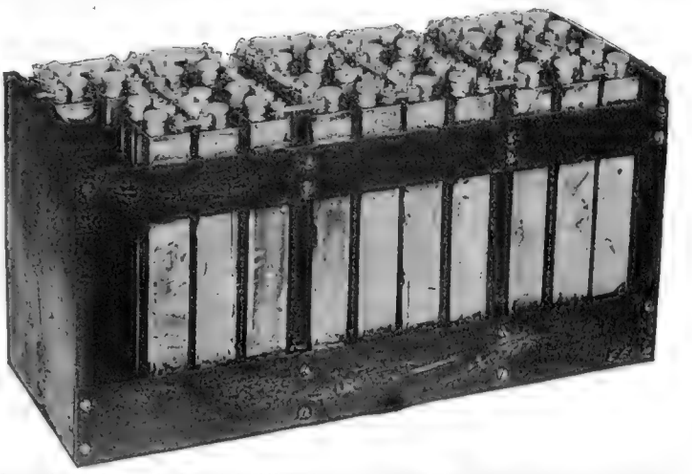
Storage Batteries for Electron Relays

By MILLER REESE HUTCHISON, E.E., Ph.D.

It is a well-known fact that the "wing" circuit of an electron relay or Audion must be energized by a source of electrical energy entirely free from pulsation of electromotive force.

Notwithstanding the splendid work which has been done in "ironing out" the commutator ripples of dynamo electric machines, there are frequent periods when, owing to any one of a number of causes, non-periodic pulsations result, which seriously affect the operation of the relay.

It is for this reason that *batteries,* both primary and secondary, have been satisfactory sources of electrical energy for the wing circuit.



Complete Set of Special Nickel-Iron Storage Cells in Carrier for Use in "Electron Relay" Circuits. The Battery Is Placed in a Steel Case, Fitted with a Folding Lid.

Until recently, batteries of miniature dry cells have been employed and have proven fairly satisfactory when absolutely new ones could be readily obtained from the factories; but such cells have a comparatively short period of usefulness, produce a "frying" sound in the receiver when polarization of the elements occurs, and are relatively expensive because of the necessity of frequent substitution by new ones, etc. These disadvantages are pronounced on shipboard, where the dampness makes the life of such a battery particularly short and uncertain, where the unreliability of any piece of apparatus is emphasized, and where a reserve stock of dry cells cannot be depended upon because of their rapid deterioration at sea, says the author in a recent paper presented before the *Institute of Radio Engineers.* On long cruises this uncertainty is of considerable moment.

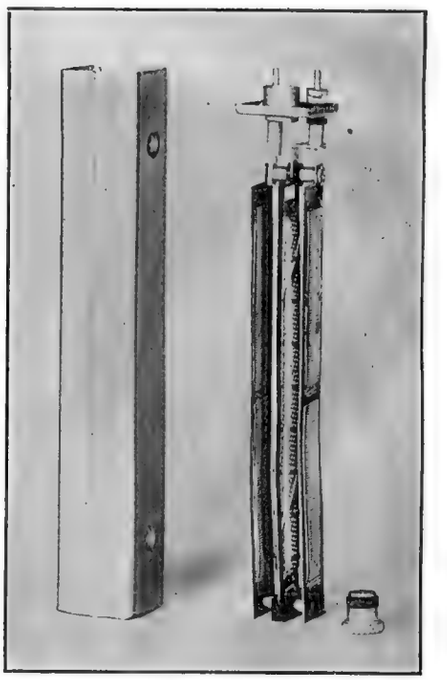
About a year ago, radio engineers and those upon whom devolves the responsibility of maintaining radio apparatus at remote land stations and aboard ship, cast about for a more dependable and more economical battery for this service.

My attention was first called to this demand by Professor Alfred Goldsmith, who, having used storage batteries in the Radio Telegraphic and Telephonic Laboratory of the College of the City of New York, was familiar with their ruggedness and dependability.

A special storage cell was thereupon developed and several batteries of these cells were sent to Professor Goldsmith for an extensive series of tests. After due time and a few minor changes, the commercially available battery appeared, incorporated with a standard size storage battery for heating the filament. Both have proven highly satisfactory in practical service and have been adopted as the standard for electron relay service by at least one Government.

A battery of any kind, for use in radio work, must, above all things, be dependable, even when subjected to the greatest of all abuse—neglect. Of course, when under the eye of a trained battery expert almost any kind of a storage battery will give good service, if the demand upon it is such as does not necessitate ruggedness; but small units, widely scattered and in the hands of many who may be entirely unskilled in storage battery practise, seldom receive more attention than an occasional charge (which may be a prolonged overcharge at excessively high rates), and the

(*Continued on page 722*)

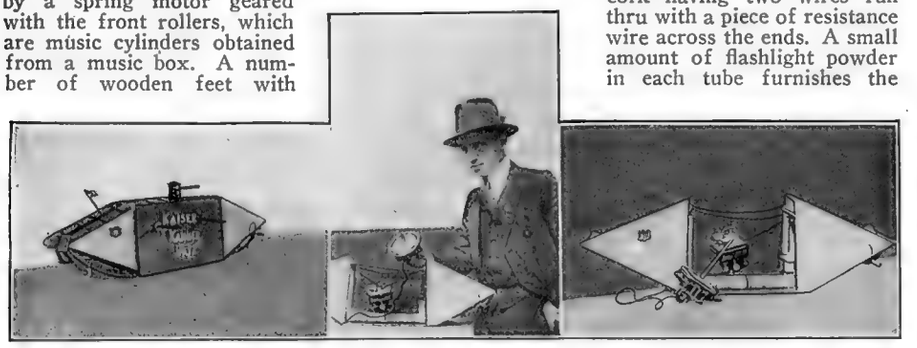


Parts of New Nickel-Iron Light Weight Storage Cell for Use in "Electron Relay" Wing Circuits.

A Radio-Controlled "Tank"

By FRANK COPERMAN

Much can be accomplisht in the art of radio-telemechanics by the aid of simple apparatus found in the experimenter's laboratory. The photos show a model radio-controlled "Tank." The frame and cover are constructed of wood, reinforced by cross wires. It is propelled by a spring motor geared with the front rollers, which are music cylinders obtained from a music box. A number of wooden feet with twisted braid on each side make up the caterpillar belts. The points on the rollers grasp the braid and carry the belt around without slippage. The belts are set on a slant so that the Tank travels in a large circle.



An Interesting Radio-Controlled "Tank" Which Fires Several Cannons and Ambles Along Just Like the Real Ones, Which the "Tommies" Are Using.

An electro-magnet to each side of the brake on the spring motor serve to throw it on and off. The coherer and de-coherer are mounted on the base of a 150 ohm relay; this in turn is suspended upside down in the center of the tank; coiled springs on each side keep it from swaying. The selective control is novel, as only one press on the key is needed to start and stop the tank or fire any one of the five guns at will. A circular piece of cardboard (see diagram) with several curved contacts, cut from copper strip, mounted as shown, is fastened over the dial of a clock-work from which the balance wheel has been removed. The minute hand is replaced by a copper strip; this moves over the contacts with moderate friction. A rod with a tin "flag" to serve as a pointer is mounted along with the copper strip as shown in the diagram. This clockwork switch is mounted in the rear end of the tank with the tin flag projecting up between the belts. The cross wires and a two foot chain pulled along behind serve as antennae to pick up the waves sent from a two-inch spark coil, untuned transmitting set.

When the clock-work switch is wound, the flag slowly revolves. If the key is closed just as the flag points over contact No. 1 the tank will start off. When the flag reaches contact No. 7 a press on the key will bring the tank to a standstill. Over any other contact a press will fire one of the guns which are brass tubes plugged at one end with a cork having two wires run thru with a piece of resistance wire across the ends. A small amount of flashlight powder in each tube furnishes the "bang." This "Tank" answers to the name of "Kaiser Kanner No. 13."

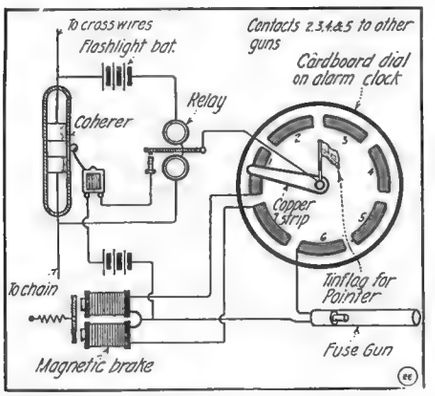


Diagram of Connections Used In Miniature Radio-Controlled "Tank"—An Interesting Model Which Every Radio-Bug Will Want To Build.

NON-RADIO COMMUNICATION SCHEME DON'T WORK?

One of the readers of the ELECTRICAL EXPERIMENTER recently complained that he had tried the ground circuit non-radio communication scheme suggested by Mr. E. T. Jones in the Sept., 1917, issue, and that it would not work.

We referred the matter to Mr. Jones, who replied to the querist as follows:

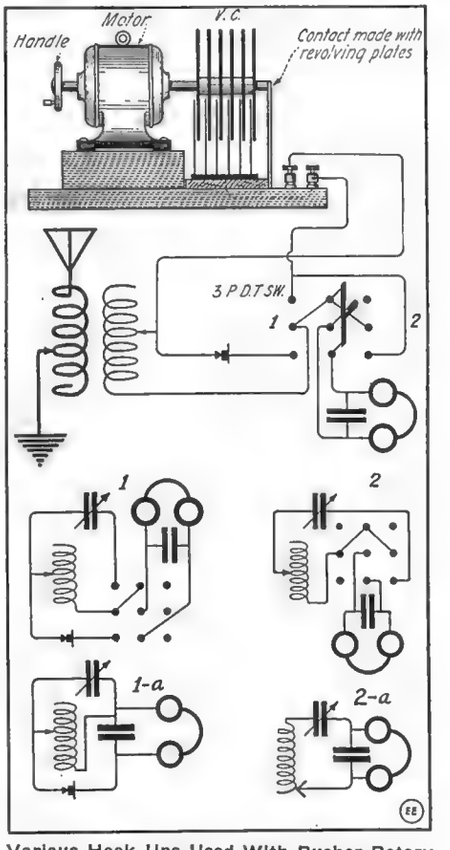
"Your letter of 12th regarding my non-radio communication system, has been handed to me by the ELECTRICAL EXPERIMENTER and I am indeed sorry to learn of your unsuccessful attempts to communicate with your friend. I will endeavor to throw some light on the subject in order that you may try this system again.

"The condensers must be of large capacity, in fact not smaller than 1 MF, furthermore you state that you are using 75 ohm phones, in this respect I may say that these phones are not sensitive enough to pick up the disturbance caused by the buzzer at the other end. I am using 2000 ohm phones with my set. Also notice that you have the three wire system, while this should not make any difference, so long as the middle wire is accepted as the grounded side, but it may be to some advantage to try both of the outside wires; that is at different intervals; try it on the other ungrounded wire instead of the one now employed. If after trying this you do not hear signals cut two lamps in series parallel, thus allowing more current to flow thru the buzzer circuit. Should this prove of no avail, then your friend must either be on a different circuit (where no metallic connection whatever is made between your house and his) or his or your apparatus is not properly connected, as no one here has had any trouble whatsoever with this system; I have worked as far as thirteen city blocks. I hope that you will obtain the desired results now."

USING THE ROTARY CONDENSER TO RECEIVE UNDAMPED WAVES.

Having noticed your special request in the last few editions for articles treating on "Wireless Subjects," I herewith submit a practical way to receive *Undamped Waves*, based on the recent Patent No. 1,233,841, printed in the "Patent Department" of THE ELECTRICAL EXPERIMENTER. Mr. Elmer E. Bucher is the owner of the above mentioned patent. As yet I have not seen in print anything referring to the reception of undamped waves using this system.

The principle of the arrangement is to have a condenser (variable) either geared or belted to a motor, which rotates the movable plates at a uniform rate of speed. Thus the capacity rises from *Zero to Maximum,* and then starts over again after having returned to the zero mark. Mr. Bucher states that this system is applicable to both spark and arc systems, but as far as I have succeeded, strong spark signals were the only ones of this character received. It works admirably well in connection with the reception of undamped waves. Owing to the above conditions, I have arranged connections which allow this condenser to be used in receiving undamped waves in its proper place (in series with the receiving circuit, same as the *tikker*), but for damped waves, as indicated in diagram, the three-pole double-throw switch is thrown in position—1. This allows the condenser to be used as the SHUNT CONDENSER across the secondary of the loose coupler, and in this position the ordinary connections used



Various Hook-Ups Used With Bucher Rotary Condenser Scheme For Receiving Undamped Waves.

for the reception of spark signals is had. Now, when the switch is thrown over on the other side (position 2) this SHUNT CONDENSER is thrown in series with the secondary, fixt condenser, and 'phones in which position the set is ready to receive undamped waves. Of course the motor is started and the condenser plates made to revolve.

There is a lot more of experimenting to be done along these lines as this is an entirely new field pertaining to the reception of undamped waves.

Contributed by E. T. JONES.
(Chief Electrician-Radio, U. S. N. R. F.)

The How and Why of Radio Apparatus

By H. WINFIELD SECOR, Assoc. I. R. E.

No. 6—Radio Receiving Tuners.

From time to time we will describe one particular instrument used in either the radio transmitting or receiving set, explaining just how it works, and why. We have received so many requests from new readers asking for such explanations, that we have decided to publish this matter in serial form. In the course of several issues all of the principal transmitting and receiving apparatus will have been covered. The subject for the sixth paper is RADIO RECEIVING TUNERS.

THE tuning of incoming radio messages is accomplisht thru some form of inductance coil or coils. The simplest tuned circuit involves the use of a *tuning coil;* as shown in Fig. 1, this comprises a single layer of wire wound on a hard rubber, fiber or other stable, insulating tube and which has an air core. The number of turns in use at any time is adjustable by virtue of movable sliders or else by multi-point switches connected up to equally spaced sections of the coil.

The hook-up, Fig. 1, shows what is known as an *auto-transformer* connection; *i.e.,* the single coil acts as both primary and secondary simultaneously. The aerial tuning circuit is formed thru lead-in, inductance, slider B, and so to ground. The closed oscillating or detector circuit is composed of the detector, slider C, inductance between C and D, slider D, and fixt condenser F.C. The telephone receivers are shunted across the fixt condenser. The 'phones are sometimes connected across the detector as indicated by the dotted lines. The former hook-up is usually preferable, especially where the capacity FC is variable, either gradually or in steps. The magnetic field set up within the inductance coil is shown by the dotted lines. It is possible to obtain higher or lower potential in the detector circuit C D, as compared to that existing in the primary by simply arranging the sliders C and D to embrace more or less turns than are in use in the primary circuit at any instant. High wave lengths are tuned in by connecting a variable condenser across the secondary sliders C and D, and also in some cases across the aerial and ground inductance terminals, depending upon the amount of inductance and capacity in the antenna. To tune in short waves, shorter than the fundamental period of the antenna circuit, it becomes necessary to insert a variable condenser in series with the ground lead as indicated at X. This reduces the capacity of the aerial circuit in accordance with the formula for the joint capacity of two or more condensers connected in series:

$$Cj = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2}};$$

where Cj is the total or joint capacity and C_1 and C_2 are the respective capacities connected in series.

The received signal current taken off in the detector circuit at C D passes thru the crystal or other detector and fixt or *blocking* condenser as shown. The crystal detector acts as a rectifier of the high frequency incoming oscillations, and the signals are heard in the 'phones.

Fig. 2 illustrates a two-coil coupling transformer or *loose coupler* as it is called in radio parlance. The primary winding is connected to aerial and ground, and is thus energized by the aerial oscillations. The oscillating magnetic field thus set up induces a similar current in the secondary which acts upon the detector and 'phones. Usually, a variable condenser is connected across the secondary coil to enable the operator to tune this circuit in syntony with the primary oscillatory circuit, with regard to frequency and wave length.

Fig. 3 shows a typical receiving circuit employing two *variometers;* one in series with the aerial lead-in to act as a *loading coil,* the other acting as a means of transferring the aerial circuit energy to the detector circuit in the manner apparent.

The variometer is a very efficient tuning instrument and acts upon a unique principle. This action is outlined at Fig. 4. Simply exprest, the variometer changes the inductance in the circuit by the reaction between the magnetic field of the primary and secondary. The complete variometer comprises two short cylindrical coils (sometimes spherically wound) with the inner and smaller diameter coil pivotally mounted within the larger stationary coil. The inner coil is connected in series with the outer one and can be revolved about its axle thru 180 degrees. Now, when in one concentric position, the two coils are connected so that their magnetic fields *oppose,* the inductance of the variometer is practically zero. If the inner coil is then turned on its axle, the inductance will gradually increase and maximum inductance obtained when the inner coil has revolved 180 degrees; *i.e.,* when this coil has completely changed sides with respect to the outer coil. This effect is readily understood from the diagram Fig. 4. The dotted lines show the magnetic field due to the outer coil "A," as well as the resultant electro-magnetic field produced by the inner coil "B." As becomes evident in the relative position of the two coils here shown, a considerable portion of the North and South magnetic field due to coil "A" is neutralized or counteracted by the South and North poles of coil "B." When coils "A" and "B" are turned until their faces align with their N. and S. poles coinciding, then it is seen how the one magnetic field will completely

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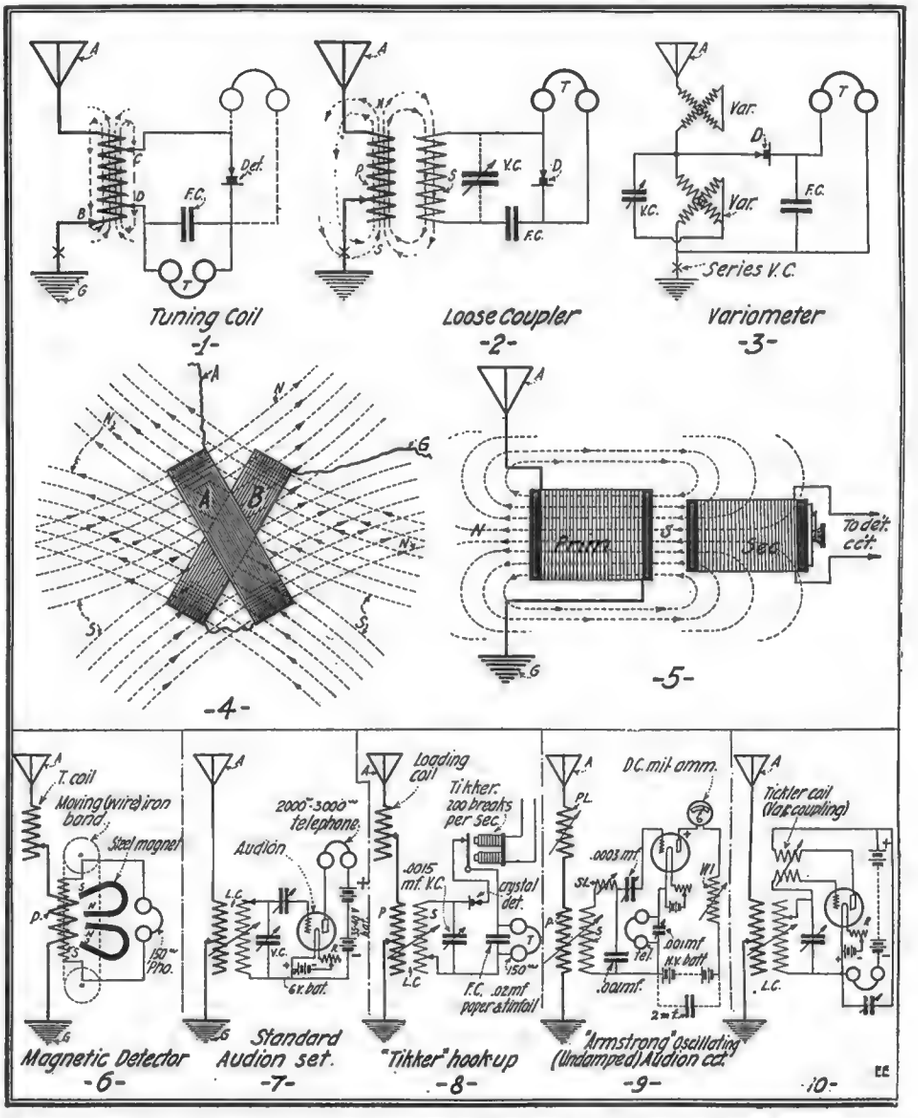
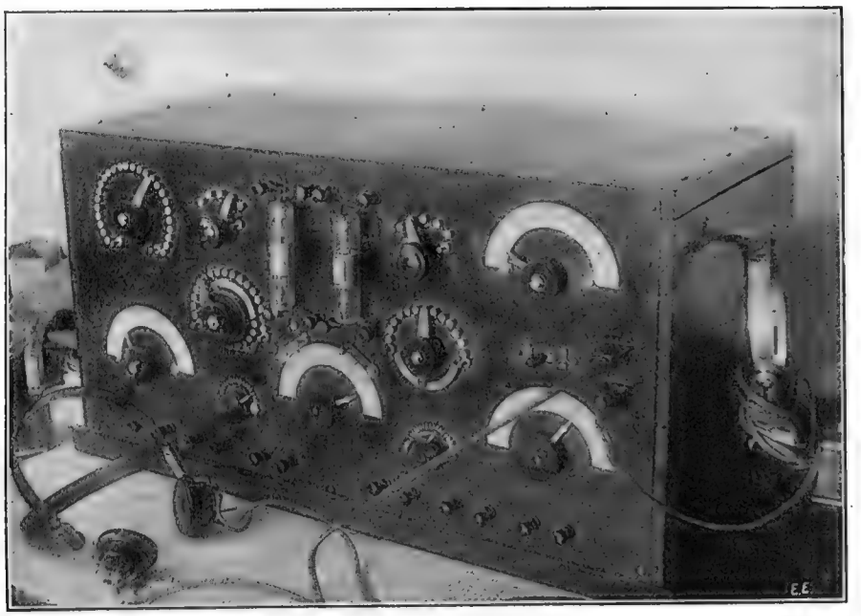


The Diagrams Above Show All the Principal Radio Receiving Circuits, Including the Arrangements for Employing Tuning Coils, Loose Couplers and Variometers. Circuits for Both Damped and Undamped Wave Reception Are Given.

Detail Construction of a Damped and Undamped Wave Receptor

By F. MacMURPHY

DURING the past year I have been studying different forms of receivers for different uses and have finally arrived at the conclusion that I have as efficient a receiver for practically all uses as can be obtained at a fair price. The set about to be described is suitable for the reception of both spark, arc and high frequency alternator stations. Credit is due Mr. A. S. Blatterman's article in this journal for suggestions made relative to this station. No greater mistake could be made by the amateur experimenter than to try to build a receiver of this type suitable for damped, as well as undamped waves, without first having a definite and sure knowledge of the principles involved, as failure will surely follow. If the receiver is to be used to receive the high-powered stations in Germany and Honolulu for example (after the war, to be sure), then it must be very carefully proportioned and thoroly understood.



Appearance of Finished Damped and Undamped Valve Receptor. It is of the Cabinet Type and is Both Efficient and Attractive.

In the accompanying diagram (Fig. 1) is shown the general design of the panel compartment. The Cabinet is made of mahogany and has a Bakelite panel 24 inches by 12 inches, ¼ inch thick, fitted into it, as shown in the figure. Tubular Audion bulbs were used in practise and sockets were substituted by four binding posts as shown in Fig. 2. This figure gives the detail dimensions of all the panel mountings; while Fig. 2A gives the side view of the cabinet showing how the panel is fitted.

Interior of Cabinet (Condensers).

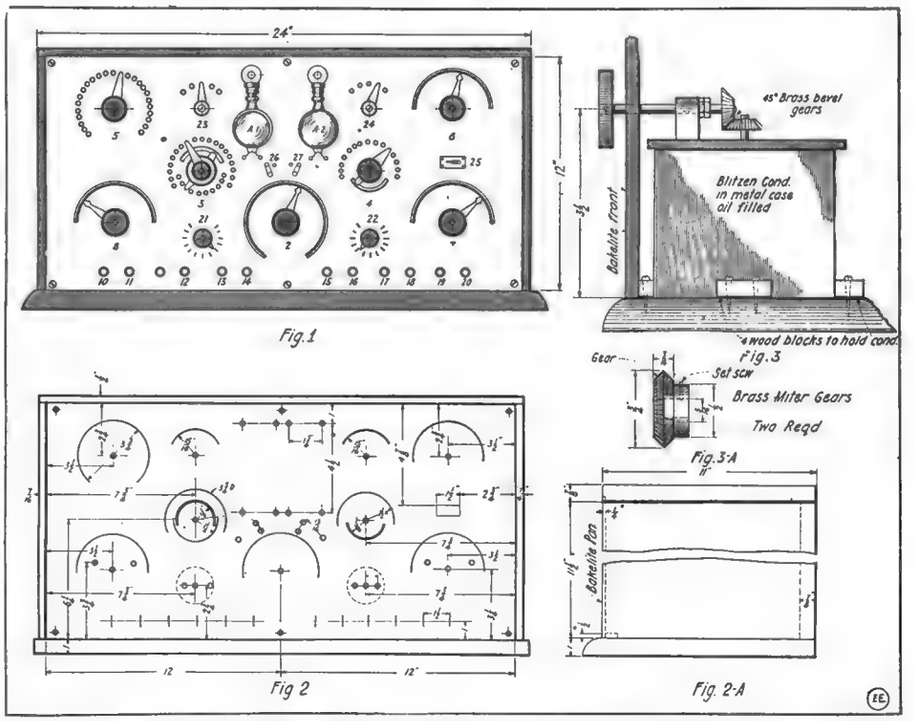
Figure 3 gives the details of the mounting of condenser No. 7. Two brass miter gears are used to work the shaft. Into the horizontal gear is fitted either by threads or set screw a rod threaded 8/32 by ¼ inch long. A brass rod, ½ inch square by 1¼ inches long, has a hole bored into it 3/16 inch in diameter to allow the rod to enter. This rod has a few threads on one end so as to allow the small threaded rod in the horizontal gear to be held together by the lock nuts. These lock nuts must be soldered together after the mounting is complete, to insure stability. Four wooden blocks hold the condenser to the base of the panel.

Figure 4 gives the details of the condenser mountings 6 and 8 as numbered, while Fig. 5 gives the details for the condenser bolts used in the above named condensers. The collars used on these condensers are ⅜ inch in diameter and are made by centering a ½-inch round brass rod in a lathe and drilling a 3/16-inch hole by means of a drill press chuck, fitted into the lathe tail-stock in place of the center. All the other collars are made in this same manner. A fine cutting tool can be used to cut the rod down a short way, after which a hack saw must be substituted. Be sure and keep the lathe in motion while the sawing is being done; otherwise a square cut cannot be obtained. In mounting these condensers to the panel, proceed as follows:—On the Blitzen condensers there are three screws which hold the stationary plates to the rubber top. Remove the two end ones and in their place fit 8/32 threaded rod which has one end threaded 6/32. Obtain a 6/32 threaded nut and and screw this on to that part of the rod threaded 6/32. Then it is only necessary to screw that part of the rod into one of the holes from which the original was taken. The nut acts as a lock to hold the condenser firmly to its top. The entire length of this threaded rod should be 1⅛ inches. If this form of fastening is used, the collars do not have to be but ½ inch in length. Two bolts threaded 8/32 by 1 inch in length are needed for the mounting of each condenser.

Rheostats.

The mountings for the rheostats are clearly given in Figure 6. The switch arm originally on the rheostat is taken off and connections made to a new shaft threaded 10/24. This shaft is 1¾ inches long. The collars on these rheostats are ½ inch high and are made in the same manner as given under "Condensers." Two brass machine bolts 1 inch long threaded 8/32 are needed for the mounting of each rheostat.

The detail mountings of switch 3, is given in Figure 7. This shaft is threaded 14/24 and is 2¼ inches long. It is necessary to drill a hole in the units switch arm considerably larger so as not to make contact with the shaft. Figure 8 gives the switch arm details which shows the brass sector needed for switches 3 and 4. The other switch details are given by Figures 10, 11 and 12. Instead of using small washers



Front View of Radio Receptor Cabinet, Showing Dimensions for Drilling Holes for Various Switches, Etc. Also Detail of Knob on Variable Condenser.

next to the back side of the panel, I prefer to drill a 3/16 inch hole in a small piece of brass sheeting ½ inch wide by about ¾ inch long as the wire connection can be soldered to the same much easier than by using small washers.

Inductance Coils.

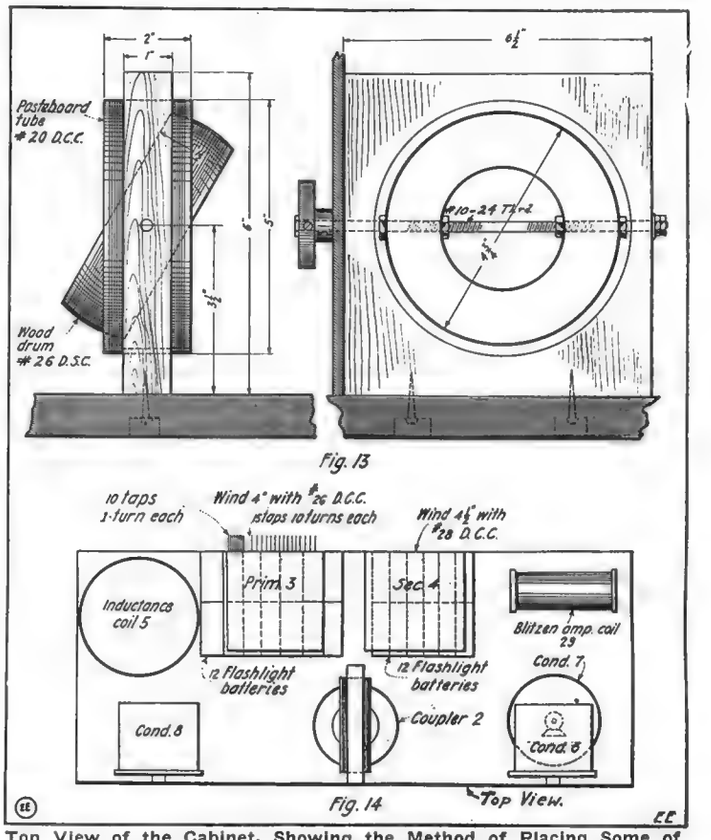
The coil No. 3 or the primary is wound on a tube 4¾ inches in diameter by 6 inches long, with No. 26 D.C.C. wire. Fifteen taps of 10 turns each are taken off, as well as 10 taps of one turn each, for the units section of the Switch 3. The secondary coil No. 4, is wound on a tube 4¼ inches by 5 inches and contains a winding length of 4½ inches of No. 28 D.C.C. wire with 12 taps taken off. As it will be noted in the wiring diagram (Fig. 15), there is a *coupling coil* numbered 34, which is not contained in the cabinet. The outside coil of this coupler is 4½ inches in diameter by 6 inches long, wound full with No. 28 D.S.C. wire, and the inner coil is 4 inches in diameter by 6 inches long, wound with the same wire the full length of the coil. These coils are to be mounted on a separate base and arranged to slide in and out of one another. It should be possible to separate them about 2 inches. The Switch 35, shown in the diagram, can best be mounted on this base. The coil No. 5 is 6 inches in diameter and 11 inches long and is wound with No. 32 D.S.C. wire having 25 taps taken off. Figure 13 gives the necessary facts to be used in constructing the small loose coupler No. 2. In the construction ot this coupler be sure and drill the holes in the wooden drum and in the support, as well as in the panel, larger than is necessary, since if a tight fit is obtained, trouble will be experienced with the nuts turning.

Conclusion.

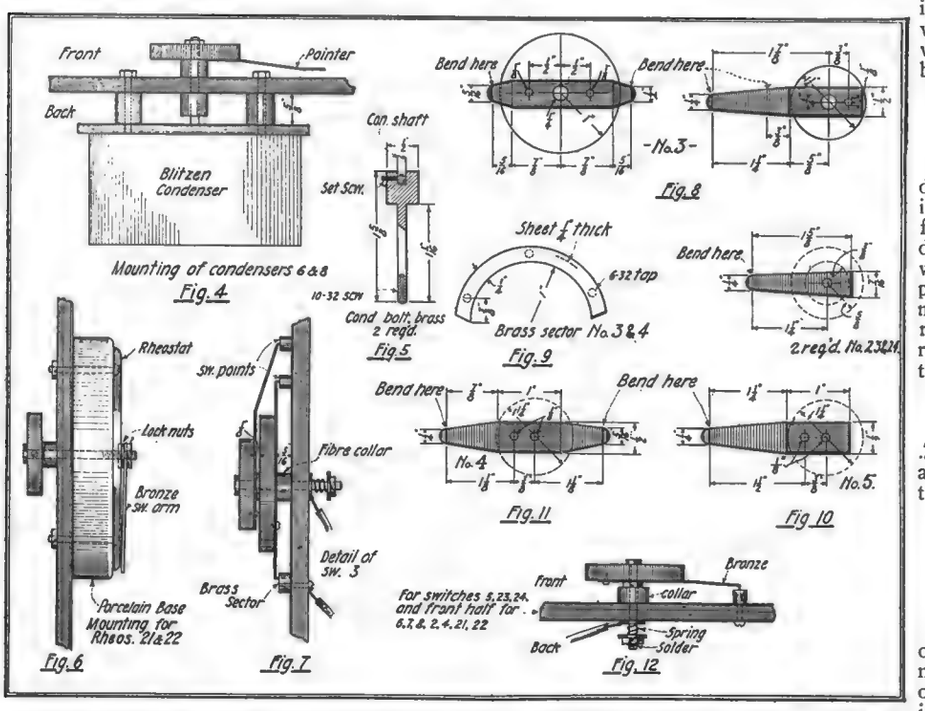
A top view of the cabinet showing the method of placing some of the apparatus in the cabinet is given by Figure 14.

If the wiring diagram as shown in Figure 16 is used, it is necessary to obtain a "Blitzen" *amplifying coil*, while if the diagram as shown in Figure 15 is used, the auto-transformer can be constructed as follows:—A core 2 inches in diameter by 14 inches in length consisting of a bundle of very soft iron wires is wound with several layers of No. 34 S. S. C. wire. About 5 pounds of this wire will be necessary.

The condenser No. 28 should consist of two sheets of tin foil 2 inches by 3 inches separated by a piece of paraffined paper. The coupler No. 30 and 31 have the following dimensions. Winding length 12 inches, diameter 7⅞ inches, wound with No. 30 D. S. C. wire for the primary coil No. 30, while coil No. 31, the secondary has a winding length of 12 inches, diameter 6⅞ inches, wound with No. 32 D. S. C. wire. The primary has 25 taps, while the secondary has 18 taps taken off. It should be possible to separate them about 9 inches. The author's transformer is capable of being separated over 12 inches. Such loose coupling is quite imperative when receiving waves of the order of 6,000 meters to 12,000 meters. The "Cambridge" tuner is almost identical in construction to the one just described.



Top View of the Cabinet, Showing the Method of Placing Some of the Apparatus, Including Variometer Type Coupler.



Various Details of Switch Parts, Variable Condenser Mountings, Rheostat Support, Etc. No Iron Screws Should Be Used In the Construction of This Receiving Set. Use Brass Instead.

The general idea involved in receiving sustained waves by the *heterodyne* or *beat* principle is to introduce into the receiving circuit a second or superimposed sustained, oscillating current of radio-frequency. These sustained waves are obtained from a sustained high-frequency generator at the receiving station. By obtaining a frequency of this local oscillation slightly different from the oscillation arriving, the two will interact, and produce a *beat* frequency which may be made quite low, and quite within the audible limits. This so-called beat frequency is then the difference be-

(*Continued on page 720*)

HOW TO REMEMBER 3.14159

To some people the following dodge will doubtless prove useful. The factor 3.14159 is in constant use for obtaining the circumference of a circle (when multiplied by the diameter) and for other purposes. Those who cannot remember the figures in their proper order will find it much easier to memorize the sentence "Now I hope I shall recollect." The words in this sentence represent the figures by the number of letters they contain, thus—

3. 1 4 1 5 9
Now I hope I shall recollect

One-fourth of the above numbers, viz.: .7854, is also in frequent use for finding the areas of circle, etc., and may be committed to memory by means of the sentence—

.7 8 5 4
Squared diameter finds area

Contributed by H. J. GRAY.

AUTHORS!!!

All matter intended for publication—not only by us, but by any other magazine or newspaper as well—should be written on one side of the paper only and in ink. If it isn't, somebody else must copy part of it off on another sheet before it is given to the printer.

THE CONSTRUCTOR

Experimental Mechanics

By SAMUEL COHEN

LESSON II.

THE LATHE

THE lathe, the topic for this lesson, is the most important tool in the work-shop, and if one becomes a thoro master of this tool, he is practically a master of most of the tools used in modern machine shops. On the other hand, if an individual is thoroly familiar with another machine such as a drill-press, milling machine, etc., he would be entirely lost when placed before a modern lathe, the reason being that the lathe embodies practically all the fundamental operations of all other machine tools. It is for this reason that the author advises the novice to become as expert on the lathe as he possibly can.

Fig. 3. A "Turning Operation"—The Piece Being Machined is Held Between the "Live" and "Dead" Centers and Driven By Means of a "Dog" Attached to the Face Plate. About the First Job Lathe Hands Tackle.

Since the lathe is of such importance in the shop, the writer will endeavor to show the experimenter how he can utilize it for many purposes other than the turning of wood or metal. Eventually he will find that he can produce a great variety of work with this single machine by the aid of certain attachments which otherwise would require several individual machines.

Some of the work which can be satisfactorily carried out with a lathe provided with the proper attachments are:—drilling, grinding, screw cutting, milling and tapering. It is therefore clearly seen that by acquiring the necessary tools for an engine lathe, a complete machine shop can be had with that individual machine. At the beginning of this course the writer discust the manner of selecting and purchasing a lathe. Now for the sake of argument let us consider that we have decided upon and obtained the type of machine desired. Further, let us assume that the machine is a nine-inch swing screw-cutting engine lathe. When receiving the machine carefully unpack the crating and see that every part is shipt with the equipment. Usually a price list containing all the parts that are included in the set is given and it is advisable to check them up with the parts sent with the lathe.

When unwrapping the lathe it will be seen that the bright parts of the machine are thoroly covered with heavy grease in order to prevent rusting. To remove this grease use a rag that has been dipt in kerosene (or gasoline), then wipe the parts dry. Clean all the gears and the various other movable parts.

The next consideration is the location of the lathe and there are several factors entering into this problem, viz:—space available; position of driving shaft and the direction of the light. The first and second factors are left entirely to the amateur, while for the third it is advisable that the light for the lathe shall enter over the right shoulder of the operator in order to obtain best results. It is very important that proper illumination should be obtained if accurate and delicate work is to be carried out.

The foundation underneath the lathe should be very rigid and care should be taken to see that no shaking can occur when the machine is running.

Before delving into the workings of a lathe let us acquire some fundamentals with respect to this valuable machine. There are various forms of lathes, each of which have their particular value. 1—The first and most common one is the foot-lathe, which by its name signifies that the revolving member is driven by means of a foot treadle. 2—A hand-lathe; one which has no means of controlling the cutting tool by means of the operator's hand. 3—Self-acting lathe; one which has an attachment to hold the cutting tool and permitting said tool to travel and be fed across the lathe bed both transversely and laterally. This arrangement is found in practically all screw-cutting engine lathes.

For the benefit of those who are not familiar with the various parts of the lathe the skeleton drawing and its corresponding key shown herewith gives the proper names of the most important parts of the machine. (See Fig. 1.) This shows a standard screw-cutting engine lathe.

The next consideration in regards to the lathe is to make a suitable foundation for it and it is essential that the lathe be securely fastened to the floor. If it is to be secured where sound flooring is not available, it is advisable to thoroly strengthen the floor by bracing in order to prevent as much as possible any vibration when the lathe is in operation. The lathe should be carefully leveled up with an accurate spirit level. The levels should be placed across the width near the head stock. Several measurements at different points along the entire length of the bed should be taken in order to see that every point is properly leveled. The *counter-shaft* should be fastened in a position so that the belt between the pulleys of the counter-shaft and the lathe are in exact line. It is necessary that the axis of the lathe spindle be parallel to that of the counter-shaft. It is, of course, not necessary that the lathe spindle be directly underneath the counter-shaft. It can be from five to fifteen inches on either side, and a great deal of judgment must be exercised by the experimenter in this direction.

As soon as the counter-shaft and the spindle cones are in proper position so that the belts will run properly, fasten the lathe firmly, using lag bolts.

A few words relative to belts will be of value especially to the novice. Leather belting is always recommended. When belting the counter-shaft to the line shaft two belts are always used. The belt nearest the head end of the lathe is usually

Fig. 4. A Good View of Actual Lathe Installation Equipt With Motor Drive. A Drilling Operation is Shown, the Drill Being Held in Tail Stock Chuck.

made straight. The other is reversed or a crost belt. The counter-shaft belt should be so arranged that when the shipper rod (the rod for changing the belt from the loose to the tight pulley) is thrown over in the direction of the lathe head spindle, the lathe will revolve so that the top of the spindle runs toward the operator when he is in front of the machine. The smooth side of the leather belt should be placed next to the pulley. The reason the belt is made smooth at one side is that in passing over the pulley there will be no air pockets. It is advisable to dress the belt frequently by means of a good belt dressing, in order that the flexibility of the belt may be retained and also to prevent slipping. In lining up two pulleys, such as those on a lathe and counter-shaft, it is the usual practise to use a piece of chalk-line. This cord is stretched taut and held against the outside edges of the pulley rims and the machine shifted until the line touches at four points, *i.e.*, both front and rear edges of both pulley rims. Pulleys of unequal face widths can be lined up thus and the narrower one reset afterward by measurement.

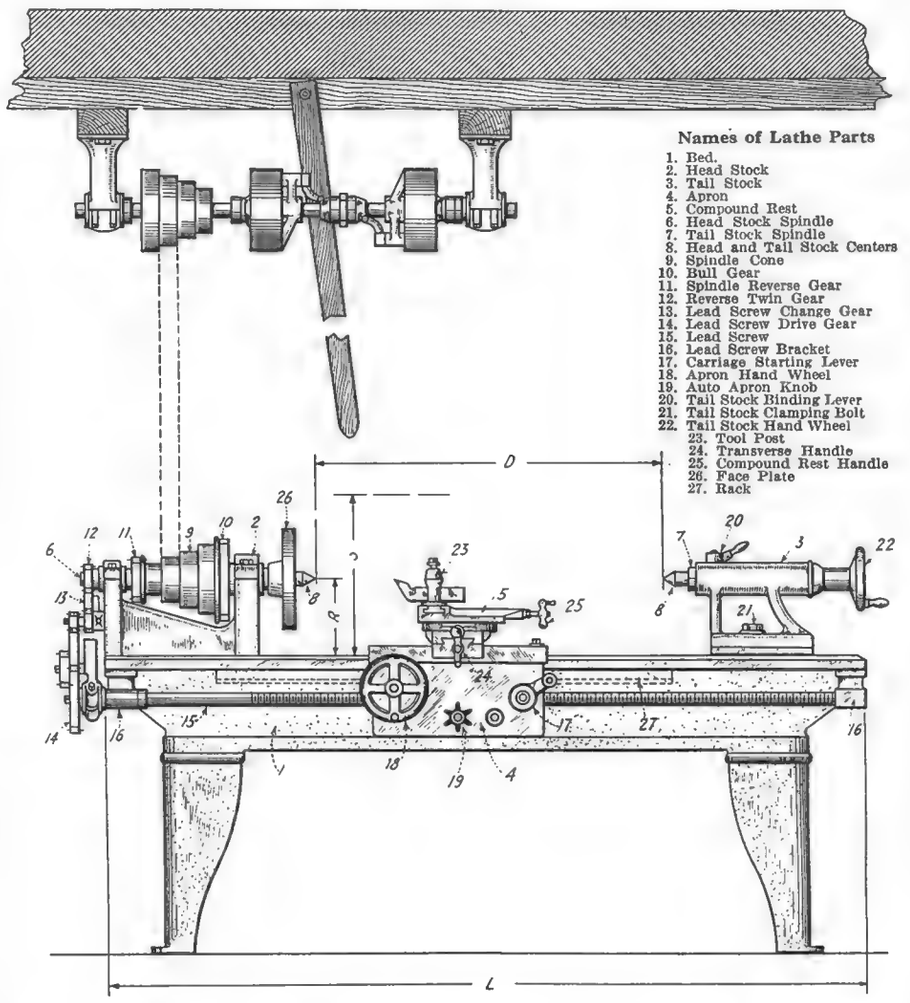


Fig. 1. This View of a Modern Lathe Shows All the Principal Parts With Their Names, As Well As the Counter-shaft With Belt Shift and Clutch Pulley.

Having belted the lathe to the counter-shaft and secured the driving motor in its proper position, the next and most important thing is to go over carefully the various parts of the machine, and see that all the parts function properly. Every oil hole should be located and a generous supply of good quality machine oil poured in them, covering each revolving part, not only to give it a necessary oiling but to make sure that any dust or dirt in the bearings will be washed out.

A great deal of attention should be exercised in seeing that all the parts in the head stock spindle and the mechanism in apron and the lead-screw bearings are well oiled. It is advisable that the lathe should be gone over at least once a day to see that every revolving part is properly oiled.

We are now ready to start the lathe and before starting see that the shipper rod is properly adjusted. See that the spindle cone bearings are properly adjusted, so that the spindle can be revolved easily by hand or by means of the back gear. Then test the back gear connection with the gear clamp, and see that the spindle runs when the back gear is thrown into action.

A very good arrangement of the gears and the lathe in general is shown in Fig. 2. This is a standard 9-inch lathe, and it is this type of lathe that the author recommends the amateur to purchase. The gears are properly protected by means of a box made from tin or sheet iron. The various reduction gears are secured to a board on the wall. This lathe is driven by means of an electric motor, which is hung from the ceiling. The motor is rated at 110 volts, ¼ horse power, direct current. The various speeds are obtained by controlling the power supplied to this motor, and this controller is stationed underneath the lathe. This is very clearly seen in Fig. 2, at the lower right hand corner. The controller is operated by a foot treadle. The switch panel as seen contains two switches, one, the main control switch, and the other the *reversing* switch. This arrangement is very satisfactory, and is strongly recommend to the amateur, this scheme providing great flexibility.

The novice is advised to carefully study the manner in which the motor is mounted. Note the two small beams on which the

(*Continued on page 717*)

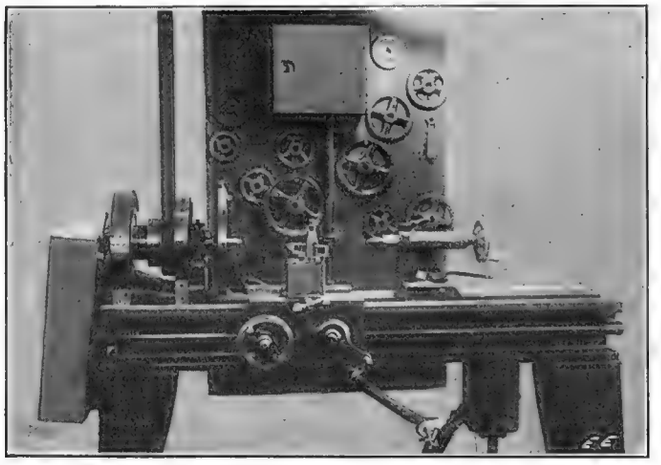


Fig. 2. General View of Lathe With Protected Gears (Left) and Foot Controlled Rheostat. An Efficient Arrangement.

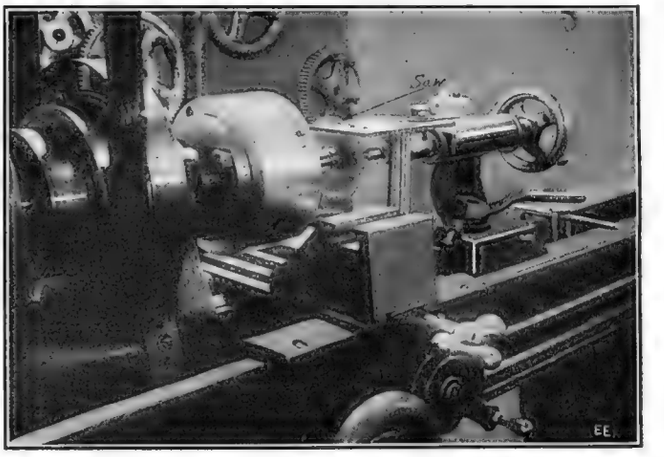


Fig. 5. This Illustrates How the Amateur Can Rig Up a Circular Saw and Table On His Lathe.

High Frequency Phenomena and Experiments

By FREDERICK VON LICHTENOW

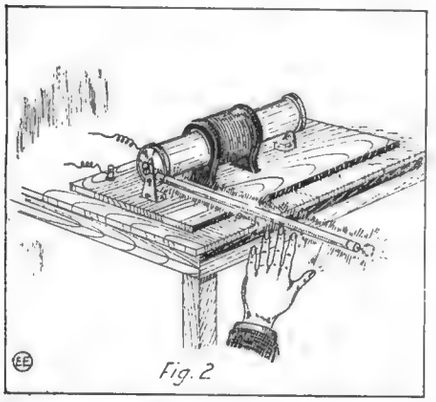
EXPERIMENTAL electricity in its various phases has always held an unresistable fascination for me. Under its captivating influence I find myself experimenting thruout the year, whenever time allows this, ever in search for the unknown trail leading to some new wonderland of electrical manifestations. This trail is exceedingly hard to find, not to speak of the wonderland beyond, in the shape of a "new discovery" The principles underlying the thousands of tried experiments are known to science; and in order to present something perfectly new, the principle involved must at the same time be a novel one. I have not succeeded that far, sorry to say, and the few experiments given here may be original only in the way in which they are offered. From a practical or mechanical standpoint they are worthless; in fact, they would cease to be experiments with the moment they could be put to a practical use.

The High Frequency "Spark Tube"—It Comprises a Glass Tube Partially Filled with Powdered Carbon. It Is Charged by "Unipolar" Current from a Tesla Coil.

EXPERIMENT No. 1.

A tube of glass about a foot long and one-half inch in diameter is filled with enough small fragments of carbon (those taken from an ordinary lead pencil or arc light carbon suffice) so that they cover its lower surface completely, when placed flat on the table. The openings at both ends of the tube are plugged up with corks, thru the centers of which short ends of brass or copper wire are inserted in order to make connection with the carbon particles. The outward protruding ends are shaped into rings, preferably soldered at the joints, (see Fig. 1). The smaller ring connects to one secondary post of the Tesla coil, while the larger one supports, and at the same time "grounds," the tube on the table.

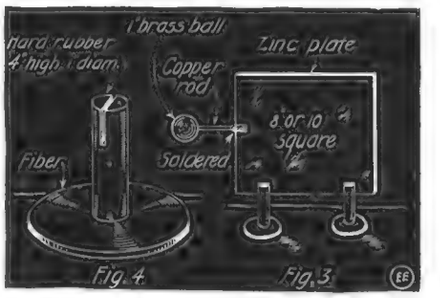
As indicated already *unipolar* current is employed. When the current passes, wonderfully blue-white sparks run in a steady stream over the carbon fragments, illuminating the whole tube, while the larger ring sends off a spray of violet light on its lower curve. Upon approaching the tube with the hand, fingers spread apart, violet streamers, accompanied by a sizzling noise, can be drawn thru the glass into each extended finger, (Fig. 2). The length of these streaming sparks depends naturally on the electrical output of the generating set used. With only a 1½ inch "Bulldog" spark coil and a standard "Electro" Tesla transformer of the same make, together with the proper condenser capacity and a spark gap provided with long, sharply pointed zinc electrodes, I was able to draw sparks one inch in length which were visible in a lighted room. However, the beauty of this experiment can be appreciated to the fullest in perfect darkness only, when the actual length of the sparks, which are really considerably longer, may be ascertained. To heighten the effect, the spark gap should be darkened also. I may add that the glass tube soon cracks under the electrical strain and has to be replaced by a new one.



If the Extended Fingers Are Approached to the "Spark Tube," Fine Sparks Will Be Drawn Thru the Glass to the Hand. These Are Harmless, Owing to the Very High Frequency. The Experiment Works Best in the Dark.

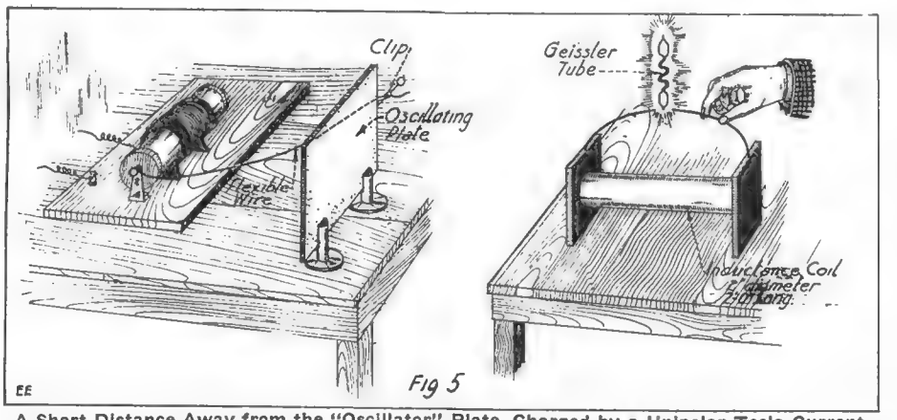
EXPERIMENT No. 2

A flexible helix wire, having a clip on one end, is connected to one secondary binding post of the Tesla coil, while the clip engages in the copper rod attached to the oscillator. This latter consists of a plate of zinc 8 or 10 inches square and a heavy copper rod, carrying a 1 inch solid brass ball, brightly polished, on its end and soldered to it, (see Fig. 3.) Hard-rubber stands as shown in Fig. 4 support the oscillating plate and afford the proper insulation. In the plane of the waves oscillating from the sheet of zinc, a large inductance coil, about 2 feet long, 2 inches in diameter, and wound with a single layer of fine (No. 36 or 38 B. & S.) insulated magnet wire, is then placed. This coil has a binding post on either end, to which pieces of stout copper wire are fastened, and may be mounted on a separate table from the one holding the Tesla set (Fig. 5). Here again the power of the generating set regulates the distance between the oscillator and the inductance coil. With the aforementioned, comparatively small outfit, this distance was limited to a foot and a half on the outside.



An Interesting Tesla Current Experiment Can Be Made with the Aid of This Metal "Oscillator" Plate. It Is Charged by a Unipolar Current and Rests on Hard Rubber Insulators.

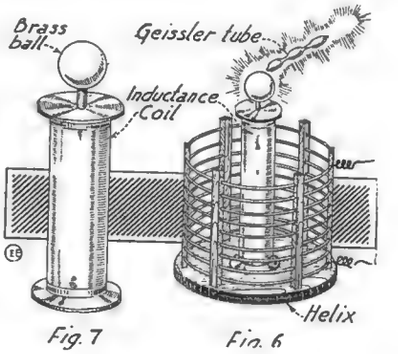
Upon the current being turned on and wires approached to within about ¼ inch, violet-colored sparks will pass between their points. If the wire on the further end is now grounded by holding it in one hand, the sparks will be increased to more than *twice* their former length. This experiment affords a very spectacular way of lighting Geissler and other vacuum tubes. The coil ends should, for best results, be constructed of some insulating material, or if made of wood this should be thoroly coated with shellac, the same as the insulated wire windings.



A Short Distance Away from the "Oscillator" Plate, Charged by a Unipolar Tesla Current, There Is Placed an Inductance Coil. The Current Induced In It Will Light up a Geissler Tube.

EXPERIMENT No. 3

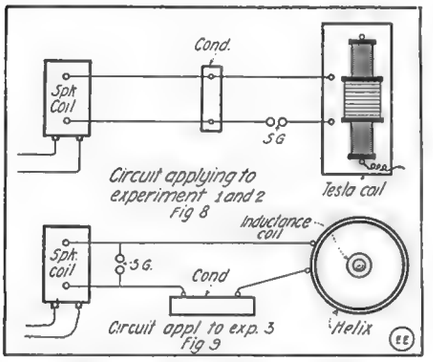
An inductance, resembling the secondary coil of an Oudin resonator is placed within the center of a helix, (see Fig. 6). At the time when this idea occurred to me, I employed a standard "Electro" helix, (after having the top removed) and a specially made inductance coil 8¼ inches in height, 2½ inches in diameter and wound with a single layer of very fine, (No. 36 or 38



An Unusual "Oudin" Coil Is Made from a Helix and a Small Inductance Coil Built as Shown. The Latter Has Brass End Cheeks Which Help to Pick up Energy from the Charged Helix, with Which It Has No Connection. The Smaller Coil Measures 8¼" by 2½".

B. & S.) silk covered, magnet wire, thoroly coated with shellac. The brass ball proper has a diameter of two inches. Both coil ends consist of solid brass instead of some insulating material for the sake of other experiments. (Fig. 7)

If the helix is now connected up as shown in diagram, sparks may be taken off at the coil terminal, Geissler tubes lighted, etc., altho this coil is in no wise connected to the circuit, both coil and helix merely working under the principle of the Tesla transformer. In all these experiments it is imperative to have the connecting wires as



Diagrams Showing How the High Frequency Apparatus Is Connected for the Experiments Here Described.

short and straight as possible and also heavy besides. Both the rubber-covered copper cable and the insulated flexible stranded copper wire are entirely satisfactory in this respect.

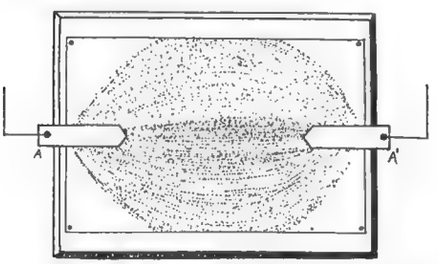
SHOWING FIELD OF STATIC CHARGE.

The following experiment to demonstrate the lines of force in a static charge can be performed by anyone having a Whimshurst static machine, such as the E. I. Co. type.

First buy or prepare some powdered glass by grinding up a few old test tubes in an iron mortar and sifting thru a fine screen. Dry a 10 x 14 inch (size need not be exact) pine board thoroly and tack a sheet of smooth drawing paper on it.

Prepare two pointed tinfoil strips AA¹ about 8 inches apart on paper and connect with the two rods of the static machine. Draw the balls on the machine far enough apart to prevent a discharge. Drive off all moisture from the powdered glass by heating it and sprinkle a light layer over paper. When the static machine is started, tap the board very lightly and the glass particles will form in curved lines, similar to the lines formed by iron filings and a magnet.

Contributed by GRANT JENKINS, JR.



The Extent of a "Static Field" May Be Illustrated by Means of Fine Glass Particles (Powdered Glass) Spread on a Piece of Drawing Paper. A Small Static Machine Will Serve to Supply the Charge.

TO PREVENT BABBITT METAL OR LEAD FROM EXPLODING.

Before pouring the babbitt metal, throw in a piece of resin the size of a walnut, and allow it to melt. This will keep the babbitt in the right shape, and if the bearings are warmed before pouring it will insure a better job.

To Mend Broken Oil-stones: A valuable oil-stone can usually be saved when broken, even if there are several pieces. The pieces must be thoroly cleaned and all oil driven from the fractures by heating on a hot plate. After this, dust powdered shellac over the broken places and heat again until the shellac melts and runs into the cracked places. The broken pieces should be heated very slowly on the hot-plate, as it is likely to burst in other places. When the shellac is well melted press the pieces together and clamp very tight. A joint so made will often last as long as the stone, and if made carefully, leaves no mar in the cutting surface.

To Keep Steel Tools in Their Handles: To keep steel tools in their handles, fill the handle with powdered resin and very fine sand. Heat the tang of the tool hot, and push it down hard into the handle. When it is cold it will be firmly set.

A Fine Lubricant for Lathe Centers: Mix together 1 part grafite and 4 parts tallow. Apply this to the moving surfaces.

To Write Black on Bright Metal or Glass: Mix 1 to 2 parts of silicate of soda with 10 parts of India ink (Higgins). Use a steel pen point and write very carefully.

Contributed by FORREST M. KIMBLE.

Amateurs! The "Smelloscope!" Your Nose Knows

Most everybody in these modern times is so accustomed to hearing of marvelous feats of science that they rarely stop to think of the whys and wherefores of things, taking much of it for granted, and forgetting the many years of toil and hardships that might have been necessary to bring the invention to perfection.

Then again there are many important developments that are doomed to pass into oblivion, owing to the fact that the inventors cannot secure sufficient capital and backing to make these inventions a success.

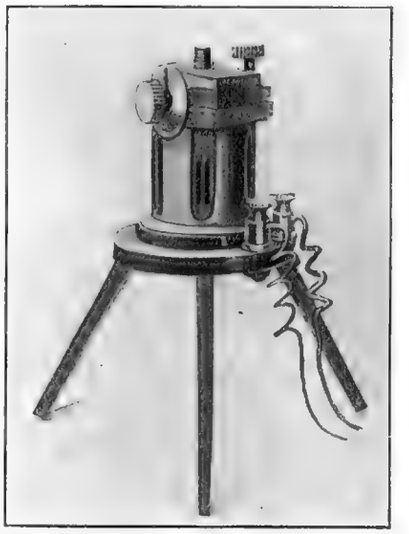
Of no man can this be said more truly than the hero of every experimenter, Mr. Thomas A. Edison. Volumes have been publisht on his early life, trials, and tribulations and the few amusing incidents that brightened his struggles.

In those days when a part such as a socket, switch or even wire was required, one had to make it and devise the machinery for making the same; nowadays, all one does it to drop in a supply store and secure almost anything wanted in the line of parts.

It is in such circumstances that the mind is given the chance for inventiveness, for "necessity is the mother of invention." Many useful and interesting things were brought out which were never brought to the public's attention, or if by chance the people saw any new development they were skeptical and soon forgot the incident.

A rather odd and little known about invention of his early work was the "odoroscope" or "smelloscope." A popular tobacco manufacturer's slogan at present to advertise his tobacco is "Rub, Smell; Your Nose Knows." Why do all this, when Edison's "smelloscope" is so handy and it saves the use of one's nose! The instrument is a modification of his tasimeter and has been named the "odoroscope" primarily from its ability to measure odors which may be inappreciable to the unaided senses. The conditions relating to the registration of moisture belong properly to the province of the odoroscope.

All odors naturally travel thru the air and the varying changes of density they impose upon the atmosphere changes the



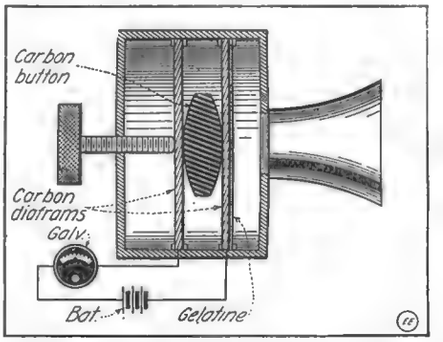
The "Smelloscope"—a Little-Known Instrument Devised by Thomas A. Edison Which Measures Smells by Electricity.

pressure, and on this principle the odoroscope works.

The instrument as may be seen from the illustration resembles very much the early type of telephone. It consists of a carbon button placed between two carbon plates. A current of electricity passes thru one plate, then thru the carbon button, and thence to the other plate. A piece of gelatine is supported so as to press against both plates. The whole is then placed in connection with a galvanometer and battery.

The action of the apparatus is as follows: Heat causes the strip of gelatine to expand and press the plates closer together on the carbon, allowing more current to pass thru and deflect the needle of a sensitive galvanometer. Cold decreases the pressure on the plates. Moisture, on which principle the odoroscope operates, if near the strip of gelatine, works the plates in the same manner by increasing or decreasing the pressure and accordingly deflecting the needle.

By means of this very sensitive arrangement of apparatus, combined with a sensitive galvanometer, it is possible to



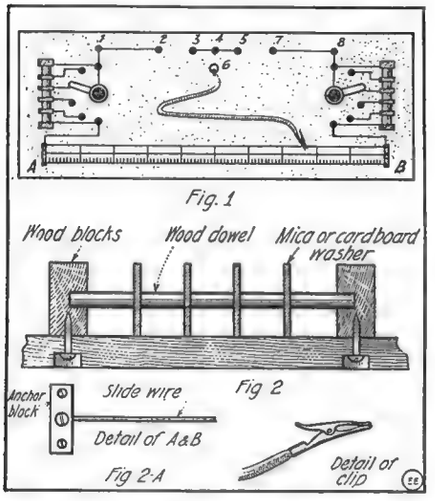
The "Insides" of the "Smelloscope"—It Comprises Two Carbon Diaframs Separated by a Carbon Button. A Gelatine Diafram Is Placed in Front of the Forward Carbon Diafram. Galvanometer and Battery Are Connected as Shown.

measure the *millionth part of a degree Fahrenheit.* Such being the case why not be conservative and use a machine to tell us what's going on in the region of smells.

The Construction of a Wheatstone Bridge

By THOMAS W. BENSON

OF the many methods devised for measuring electrical resistance the *Wheatstone bridge* has proven itself superior by every test. Utilizing the zero method, that is, a network of resistance that must be balanced so that no indication is given on the meter



View of Finished "Wheatstone Bridge" and Detail of Resistance Bobbin. This Bridge Is of the Well-Known Side-Wire Type.

or galvanometer, all errors due to unforeseen changes in the electromotive-force are effectively eliminated and a high degree of accuracy maintained.

Experimenters often have use for a Wheatstone bridge and too often fall into the belief that they are difficult to construct and handle. This is more or less true with the Post Office type using plugs in both the ratio and rheostat arms, but a slide-wire bridge as described herewith can be built at a small outlay and enables the experimenter to check accurately the resistance of various instruments and devices. It can also be used in determining capacities and inductances by using the proper standards in the rheostat arm.

Being of the slide-wire type the balances are quickly obtained with a minimum of trouble and the construction is simple and cheap. By a special design ratios as high as 50 to 1 are readily obtained which gives a resistance measuring range from 50,000 ohms to .02 ohms, with a high degree of accuracy. The above is accomplisht with a slide-wire but 20 inches long and a rheostat arm with a maximum resistance of 1,000 ohms.

At Fig. 1 is given the general layout of the base, which is 24 inches long and 8 inches wide. After smoothing up the surface and shellacking, holes are laid out and drilled for the two six point switches, the slide-wire blocks and the eight binding posts. The details of the blocks for the slide-wire is shown in Fig. 2 A. Two pieces of ¼ square brass rod each two inches long, are drilled with three holes as shown. The hole in the center is tapt for a No. 8-32 screw to hold the wire, the other two holes are for fastening to the base.

These blocks are mounted on the base exactly 20 inches apart. A scale is made from a strip of paper and divided up into 100 equal parts and numbered. This scale is fastened to the base between the blocks as shown.

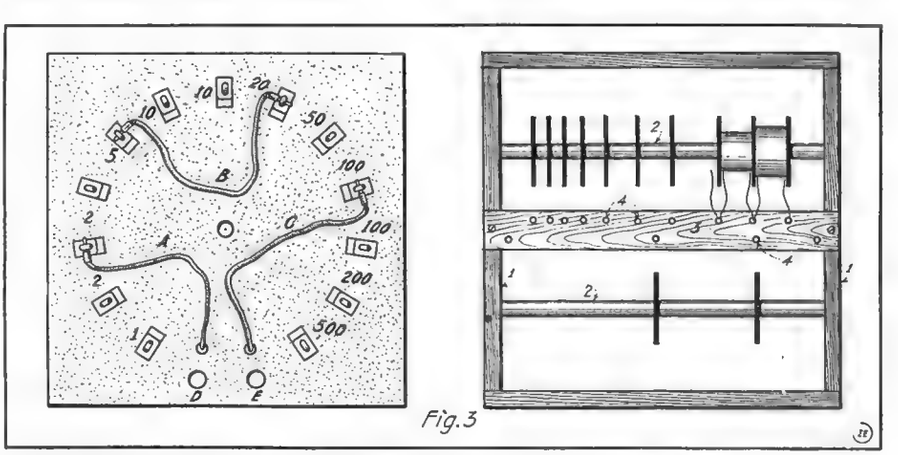
The two six point switches illustrated control two sets of resistance coils that can be added to the slide-wire and thus give a greater range of ratios. The winding for each of these coils consists of exactly 20 inches of No. 24 S. C. C. Climax wire. The method of supporting the windings is shown in Fig. 2.

A piece of ⅜ inch wood dowel three inches long is fitted with square heads cut from wood. Holes drilled in the heads hold the dowel. Four washers made from fiber are slipt over the dowel and equally spaced. In winding the coils, first cut off exactly 22 inches of the wire, double it upon itself and wind into place on the dowel. When all five coils are wound the spool may be covered with tin or cardboard and painted if desired. The ends of the wire are carried to the contacts and soldered. Care should be taken that one inch of the wire is used for the purpose, thus leaving twenty inches in use. The coils are wired to the contacts so that they will be in series.

The wiring for the eight binding posts is shown in the illustration. The wire should be of fairly large size and soldered at all points to prevent poor contacts. It will be noted that the switch levers are connected so that they short-circuit the resistance coils. The movable contact for the slide-wire consists of a spring clip cut and filed to a point as illustrated. The flexible cable to which this is soldered can be made of lamp cord, the other end being fastened to the binding post 6.

The slide-wire itself consists of a length of No. 24 Climax wire, which is drawn taut (but *not stretched*) between the two brass blocks. This wire should be renewed when it shows signs of being scratched or badly stretched. This completes the bridge proper so we will turn our attention to the rheostat.

The details of the rheostat are shown in Figs. 3 and 4. Twelve resistance coils are required, namely, 1, 2, 2, 5, 10, 20, 20, 50, 100, 200, 200, 500 ohms respectively. This gives us a range up to 1,000 ohms in steps of 1 ohm. Instead of using plugs to vary this resistance use is made of spring binding posts, connected with flexible cords. In the figure the box is arranged for a resistance of 157 ohms. The coils are connected in series between the binding posts and by shunting out unwanted coils any desired resistance may be obtained.



Illustrating Resistance Box Containing Coils of Known Ohmic Resistance and Arrangement of Spring Binding Posts. By This Means It Becomes Possible to Readily Change the Resistance in Circuit.

The interior of the box is arranged as illustrated in the figures. The windings are supported on two wood dowels as in the previous case and separated by fiber washers. The box measures 7 by 7 by 3 inches inside. The strips 1 and 1 support the dowels, while strip 3 has contacts placed on it to which the ends of the windings are soldered.

We now come to the most difficult part, that is the making of the coils which must have a known and accurate resistance. This is not so important in the ratio arms, since we can take it for granted that the resistance varies directly as the length, therefore units of length can be used in the formulas. Here, however, known resistances must be used.

To one having access to a standard bridge this is not difficult, but inasmuch as we have not a standard bridge we shall use the bridge just constructed to measure the coils for the known resistances.

To do this it is necessary to have a standard 1 ohm coil. This may be purchased or perhaps borrowed from some friend.* The resistance wire required should be No. 24; 1 lb. of this wire costing about $2.00 will be sufficient to build the rheostat. S. C. C. Climax wire is advised for the purpose.

To make the coils, wire the bridge as shown in Fig. 5, where Y is the known standard of 1 ohm. One or two dry cells will do for the battery; the galvanometer may be replaced with a telephone receiver and a balance is then obtained when *no click* is heard in the receiver when the contact is touched to the slide-wire. The switches are placed on the first point so the resistances are cut out and the movable contact is connected to the slide-wire over the middle of the scale.

The No. 24 Climax wire has nearly 1.3 ohms resistance per foot. Therefore for the 1 ohm coil take about 14 inches of the wire, double it and wind it on the dowel. Solder one end to one of the contacts on the strip 3, Fig. 3, and connect this contact to the post A, Fig. 5. A wire is carried from the other post B and is moved over the other end of the coil of wire under construction till the galvanometer indicates a balance by remaining stationary. The wire on the resistance coil up to the point where the heavier wire touches it, has a resistance of 1 ohm, it should be soldered at that point to another contact on strip 3, Fig. 3. We now have the first

*Write the Editor, inclosing stamped envelope, and address of concern supplying these coils will be furnished.

standard resistance coil of 1 ohm value.

This coil is now connected in series with the standard resistance to form a rheostat arm having 2 ohms resistance. By taking two feet of the wire, doubling it and winding on the dowels and proceeding as in the previous case to get a balance, the two ohm coils can be constructed. This process is continued till all the coils are made. By keeping the movable contact on the slide-wire at the center, the ratio of these arms is 1 to 1; therefore when the known resistances are put in one arm the same resistance will be in the other arm when a balance is obtained.

In making the larger coils it will be found advisable to wind them on a small paper tube that will slide over the dowels, thus making it easier to handle.

When all the coils are in place the contacts should be connected to the bolts holding the spring binding posts on the top of the box. This completes the rheostat.

The only other instrument that is used in connection with the bridge is the galvanometer. The construction of these have been described from time to time in the ELECTRICAL EXPERIMENTER, but the writer prefers to make use of a center zero ammeter with the shunt removed. These can be purchased quite cheaply, in fact, the one the writer is using for this kind of work at present cost but 50 cents. Telephone receivers can be used but have the disadvantage of not indicating whether the rheostat is of too high or too low a value; thus if the resistance to be measured is not known approximately it takes some time to get a balance.

As to using the bridge. The complete connections are shown in Fig. 6. After connecting as illustrated, resistance is plugged in on the rheostat to about the same value as the unknown or X resistance. The switches A1 and B1 are placed on the first point so as to cut out these coils. Touch the movable contact at several points along the length of the slide-wire. Should the galvanometer swing one way when the contact is at one end of the wire and the opposite way when it is at the other end, a balance will be obtained somewhere on the length of the wire. When the point is reached where the galvanometer gives no deflection the following formula applies:—

$$\left(X = \frac{B}{A} \times Y\right)$$

Where:—X is the unknown resistance.
B is the number of divisions between the movable contact and the right hand end of the slide-wire.

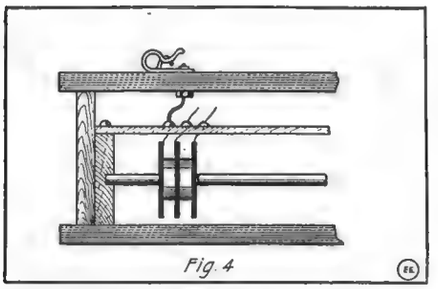


Fig. 4

Resistance Unit in Place in Cabinet, Showing How Connection is Made to the Spring Binding Post Terminals.

A is the number of divisions on the left hand side of the movable contact.
Y is the value of the known resistance.

Sometimes it will be found that the galvanometer will show a deflection in the one direction when the contact is placed at either end of the wire. The method to remedy this and get a balance is as follows: Determine which end of the bridge the lowest reading on the galvanometer is obtained, then move the switch at the *opposite end* over one contact and try for a balance. Should it then be possible to balance it, add 100 divisions to the reading of side of the bridge on which the switch is moved.

When measuring resistances higher than 1,000 ohms, switch A1 is left on the first point and switch B1 is moved over a number of contacts to get a balance. When measuring resistances within the range of the rheostat both switches are on the first point and for resistances below 1 ohm, switch A1 will have to be moved and switch B1 left on the first point.

Always add 100 to the scale reading for each contact that the switch is moved over, or the calculated resistance will be wrong.

ELECTRICAL CONDUCTION IN METALS AT LOW TEMPERATURES.

The experiments of H. Kamerlingh Onnes on the resistivity of metals at liquid helium temperatures have shown that certain metals possess an enormously increased conductivity when the temperature, current density, and magnetic field are less than certain critical values. It is pointed out by

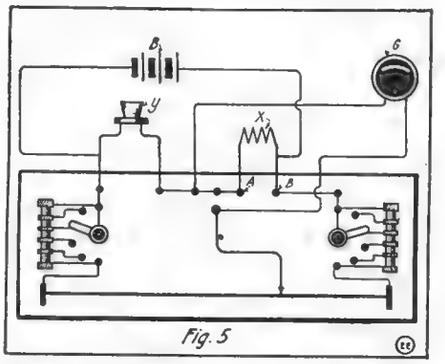


Fig. 5

One Connection of the Slide-Wire Bridge, Using Individual Resistance Units of Known Value at "y"; Unknown Resistance at "x".

Francis B. Silsbee, in a recent publication of the Bureau of Standards, that a definite relationship is to be expected between the values of critical current and critical field, and that this relation is in agreement with the experimental data available.

The present state of our experimental knowledge of this subject is somewhat as follows: Certain metals—mercury, tin, and lead—at the very low temperatures obtainable in a bath of liquid helium show a very greatly increased electrical conductivity, to which Onnes has given the name "superconductivity." The actual resistivity of the metal in this state is too small to measure but has been shown to be less than 2.10^{-11} times the resistivity at 0 ° C. As the temperature of any of these metals is lowered from room temperature the resistance decreases uniformly with the normal coefficient of about 0.4 per cent per degree until the temperature is very low, when the rate of decrease becomes for a time less rapid. At a certain critical temperature, however (4°.2 K for mercury, 3°.8 K for tin, and 6° K for lead), there is a sudden break in the curve connecting resistance and temperature, and within a temperature range of a few hundredths of a degree the resistance drops from about 10^{-8} times its value at 0 ° C to less than 10^{-10} times the same value. Other metals, such as gold, silver, platinum, iron, etc., do not show this phenomenon, and their resistivity tends to approach a constant value as the temperature is lowered to the lowest value (1°.6 K) at which such measurements have been made. The critical temperature at which the

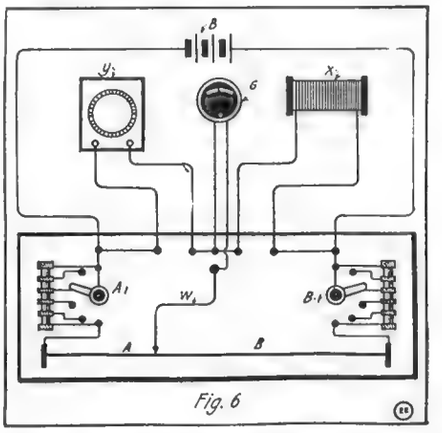


Fig. 6

Another Connection of the Resistance Bridge With the Home-Made Resistance Box of Known Values at "y" and Unknown Resistance Being Measured at "x."

change occurs is very definite when the current used to measure the resistance is small, but when the measuring current is very large the critical temperature is found to be definitely lower. Conversely, if the temperature of the bath be held constant some degrees below the critical value and the current be increased a certain "threshold" value of current will be found at which the resistance suddenly appears. The lower the temperature the greater the value of the critical current.

It is further found that when a superconductor is placed in a weak magnetic field it remains superconducting, *but that as the field is increased the normal resistance appears suddenly at a certain critical value of the magnetic field, and for still higher values of field increases slowly with the field.* The critical value is slightly less when the field is transverse to the direction of current flow than when it is longitudinal, but the difference is not great.

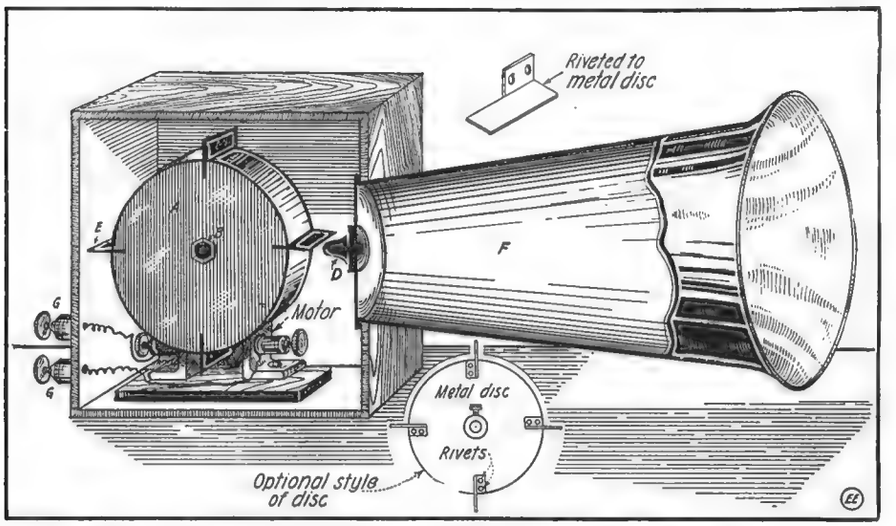
The particular point which is the subject of this discussion is that *the "threshold" value of current is that at which the magnetic field due to the current itself is equal to the critical magnetic field.* In other words, the phenomenon of threshold current need not be regarded as a distinct phenomenon to be explained by heating, etc., but is a direct result of the existence of the phenomenon of threshold magnetic field.

In case the specimen is in the form of a flat coil of wire it is evident that the inner turns are in a magnetic field, due to the current in the other turns, which is very similar to that due to an entirely external electromagnet. Consequently, when upon increasing the current this field reaches the critical value, first the inner turns will become resisting and, as the current is increased, more and more of the wire will cease to be super-conducting. Because of the enormous factor by which the conductivity decreases from the superconducting to the normal state most of this decrease will take place when only a small fraction of a turn of the coil ceases to be superconducting. Owing to the cumulative effect of the successive turns the field produced by a given current is much greater in the coil than in the same wire when straight and consequently the current required to give the critical field strength will be much less. This is verified by the results of Onnes on coils of lead and tin wire, which showed critical currents one-fifteenth and

(*Continued on page 714*)

A MOTOR-ACTUATED SIGNAL HORN.

Herewith is a diagram of an electric motor-actuated horn of my own design. At A we have a metal disk fastened to B, the pulley of the motor. D is a diafram fastened to an opening in a small box in which the motor is mounted.



Here Is an Electric Signal Horn Operated by a Motor. It's Right There with a Wallop. Can Be Used for Auto or Factory Signaling.

Small strips of heavy sheet metal, E, are fastened to the disk A, and of such a length that they will just hit the diafram in revolving. The rotating disc may be made of ¼ inch fiber, about 3 inches in diameter, the metal blades E being let into slots sawed on the periphery. If the disc is of metal then the strips E can either be soldered or riveted to it. G and G represent binding posts to which wires are attached from and connected with a battery and push button in the usual way. The faster the motor runs, the higher the tone. Contributed by BRIANT F. BRANTING.

ELECTRICAL PROPERTIES OF COPPER.

The following excerpt is taken from a very interesting pamphlet by courtesy of a well-known Copper Company:

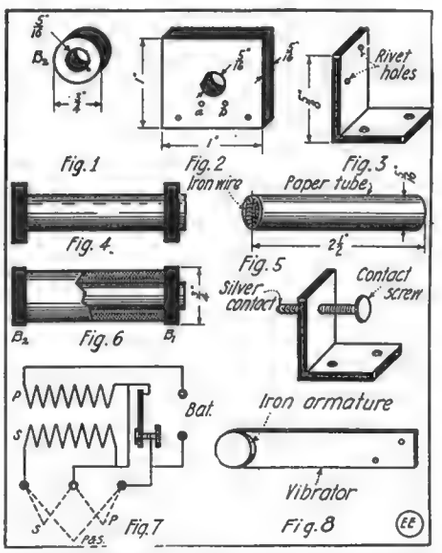
Density annealed copper at 20 deg. C..	8.89
Melting point Deg. C.	1083
Melting point Deg. F.	1981
Boiling point Deg. C.	2310
Latent heat of fusion	43.3 cal
Specific heat at 25 deg. C.	0.0917
Specific heat at t deg. C.	0.0917 + 0.000048 (t—25)
Thermal conductivity (Silver-100)	73.6
Vapor Tension at 1120 deg. C.	0.28 mm.
Co-efficient of linear expansion per Deg. C.	0.000017
Tensile strength No. O wire annealed pounds per sq. in.	32000.
Tensile strength No. O hard drawn wire pounds per sq. in.	54500.
Elastic limit No. 0 wire hard drawn pounds per sq. in.	30,000.
Tensile strength pounds per sq. in. for any given diameter (D") of hard drawn wire.	70,000-45,000 D
Standard Resistivity annealed copper at 20 deg. C.	
Microhms—cm.	1.7241
Microhms—inch.	0.67879
Ohms (meter-gram)	0.15328
Ohms (mile-pound)	875.20
Resistivity Temp. constant per Deg. C.	
Microhms—cm.	0.00681
Microhms—inch.	0.00268
Ohms (meter-gram)	0.000597
Ohms (mile-pound)	3.41
One cubic inch cast copper weighs..	31 lbs.

How To Make a Medical Coil

By E. F. JASPERS

A MEDICAL coil, or shocking coil as it is commonly termed, is nothing more nor less than a small induction coil having a core, primary and secondary windings and an interrupter (vibrator).

The first step in constructing a medical coil is the making of the tube which holds the core. This tube is 2½" long and 5/16" in diameter. It is formed of ordinary paper rolled and glued together and is afterward filled with No. 22 B. & S. gage soft (annealed) iron wire, Fig. 1.



Details as Well as Connections for Medical Induction Coil. To Obtain Best Results the Vibrator Should Be Fitted with Platinum Contacts.

The ends of the coil are made out of a piece of fiber 1" square, with a 5/16" hole in the center, Fig. 2. The other end is ¾" round with a 5/16" hole in the center,, Fig. 3. These coil checks are glued to the core tube, leaving enough to project at one end for the interrupter, Fig. 4.

The core is then wound with four layers of No. 22 B. & S. gage single cotton covered magnet wire. The ends of the wire are led out of the holes A and B, which have been previously made. The primary should be covered with three layers of waxed paper, after which it should be wound to within 1/16" of the top of B, with No. 34 B. & S. gage single cotton covered magnet wire, Fig. 6. It is best, but not absolutely essential, to place a layer of thin waxed paper between every two layers. That known as onion-skin paper is excellent for small coils such as this.

The interrupter used on the medical coil is one of the simplest forms and can be best understood from the drawing. The contact points should be provided with a piece of silver which is taken from a ten-cent piece and soldered on. Platinum or tungsten points are best; for cheap coils nickel or German silver is often used.

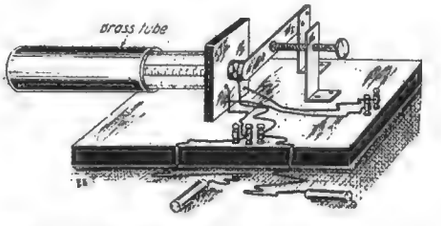
The medical coil parts are now ready for assembling. One wire of the primary should be connected to one of the battery binding posts, while the other should be connected to the vibrator. A jumper lead connects the contact screw and the remaining battery binding post. Thus, when a battery is connected to the two binding posts, the current will enter the primary and come thru the vibrator spring to the contact post and then back to the battery, forming a complete circuit.

As soon as the current flows it produces a magnetic field which attracts the vibrator spring, breaking the circuit; the core thus loses its magnetism and frees the vibrator spring, which flies back to the contact post, only to be drawn forward against the core once more, this action being repeated at a high rate of speed.

The secondary terminals are led out to two of three binding posts as shown, to which are connected two electrodes, which may be made out of the carbon from an old dry cell or a piece of copper or brass tubing. Refer to Fig. 7, for connections used whereby to obtain primary shock (two right-hand posts), secondary shock from two left-hand posts, and combined primary and secondary shock from two outer posts.

The medical coil is now completed, except for testing. If you grasp the electrodes while the battery is connected to the binding posts, a powerful shock will be felt. The shock can be regulated with a tin or brass tube, ⅞" inside diameter and 2" long.

When this tube is all the way off, the shock felt is the strongest, and when the tube is all the way over the coil, the shock is weakest. Of course, any shock between the two extremities can be had by sliding the tube in or near the middle. A graduated scale may be pasted on the coil so that the regulating tube as it slides off, will expose more and more of the scale—the figures reading in an ascending ratio.



View of Finished Medical and Shocking Coil. The Brass Current Regulating Tube Is Placed on the Outside of Both Primary and Secondary.

The secondary coil should be covered with a layer or two of paper, glued in place. A coil of this type is very useful.

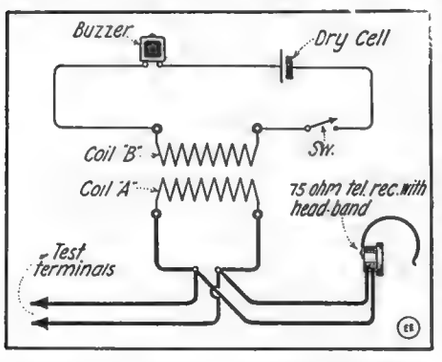
A Portable and Reliable Armature Test Set

By FRANK HUSKINSON

THE electrician frequently has a motor with the armature grounded; that is one or more of the armature wires or commutator bars are burnt and making contact with the iron core. This *ground* as it is called by electricians, has to be removed before the armature will run, the wires must be reinsulated so as to not make contact with the iron core, or in case the wires are in bad shape or the coil is *shorted* as well as grounded and can not be repaired, there being no time to put in a new coil, the remedy is to cut out the burnt or grounded coil and close the open circuit in the commutator. Armatures that are in use on commercial motors, may have several coils cut out and will give good service for an indefinite time; it is not always possible or advisable to rewind an armature, if the trouble is only due to one or more coils being grounded or short-circuited.

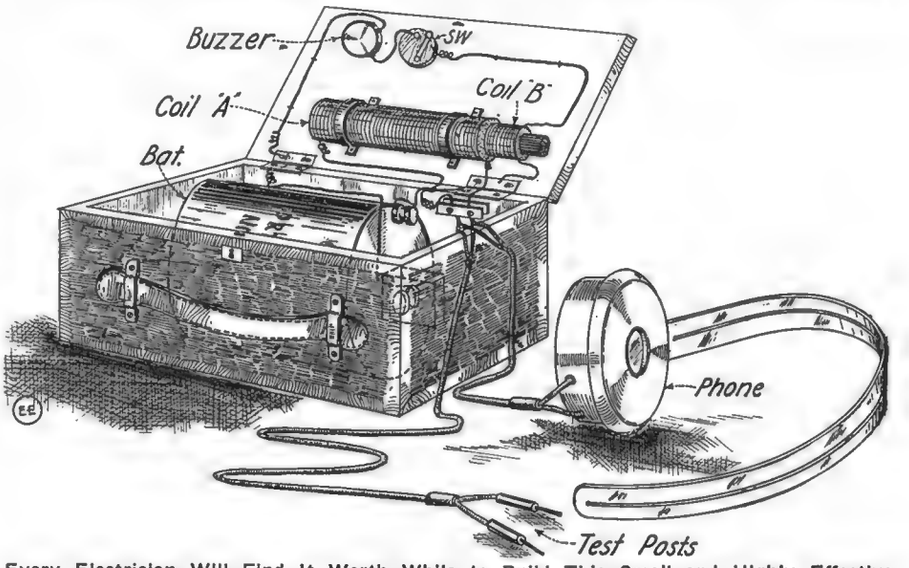
It frequently happens that an armature has a grounded coil and upon a very careful examination it does not show up on the visible parts of the armature, but by testing with a lamp between the armature shaft and the commutator the lamp will light up to its full candle-power. This indicates that the coils are grounded in some part of the armature. In order to find the exact coil that is grounded the old-time method was to remove all the wires from two or three commutator bars on each side of the commutator, then test with the lamp to find out if by chance the trouble was in one of the halves. It is very seldom that it is, then the next move is to remove all the wires from other sections of the commutator and keep this up and test with the lamp until the *exact coil is located.* This method takes considerable time and generally the band wire next to the commutator has to be removed so that after the coil that is grounded is located and cut out or repaired, all of the wires that have been removed from the commutator must be reinsulated, replaced and resoldered in the commutator and the band wires rewound on the armature. It is very seldom that an armature can be repaired and ready for use in less time than five to twenty-five hours by the old-time method.

The writer has a test set that he made several years ago and has used it at all times. It can be used to locate a grounded coil or commutator bar, or a coil that is short-circuited. The writer has often found that an armature that tested grounded and would not run, upon examination had no visible trace of the ground,



Connections Used in Portable Armature "Test Set." The Use of a Telephone Receiver Makes This Set Extremely Sensitive—It Being Possible to Check Up a Single Short-Circuited Turn.

but by using the test set shown he located the *exact coil* that was grounded. The wires are then removed from the commutator and tests made with a lamp to see if any other coils are grounded and to check the test; finding the other coils clear of a ground, the ends of the grounded coil are then cut off or bent back away from the commutator. The open circuit caused by the removal of the coil is then closed and the armature is ready for use again. The writer has on several occasions removed such grounds in the manner just described from armatures and had the motor back in operation in less than an hour.



Every Electrician Will Find It Worth While to Build This Small and Highly Effective Armature and Field Coil "Test Set." It Utilizes an Induction Coil, Battery, Buzzer and Telephone Receiver.

A complete description with diagram is given below so that any electrician can very easily make the set for his own use at a very small cost and will find it an indispensable aid in his daily work. It is absolutely reliable and in the use of it the condition of the coils is noted by the degree of sound heard in the receiver. This test set will instantly reveal the presence of short circuits and open circuits and of grounded coils in an armature. If the coil is open circuited the sound in the receiver is *very loud,* if the coil is short-circuited the sound is *very low;* the tests for opens and shorts are made by touching the test terminals on adjacent commutator bars. In testing for a ground, one of the test terminals is held on the armature shaft while the other one is touched to each commutator bar successively and as the grounded coil is approached, the sound in the receiver diminishes and when the exact commutator bar is touched that has the grounded coil connected to it, there is practically *no sound* at all in the receiver. Upon locating the ground this bar is marked, and then the test is continued around the commutator until the other side of the coil is located, then the wires are removed from the commutator, and the grounded coil repaired or cut out.

To make a Test Set.—In the diagram are shown the connections of the Test Set. To make coil A. wind enough No. 8 D. C. C. magnet wire on a wooden form ⅞" diam. to make a single layer coil 6" long; remove the form and you will have a hollow coil of wire. Form the ends to make a support as well as terminals. To make coil B, cut enough pieces of No. 18 soft iron wire to form a core 6½" long by ½" diam. Insulate this core and wind on it two layers of No. 20 or 22 D. C. C. magnet wire, leaving about ¼" of the core on each end without windings; this will bring the two ends of the wire out on the same end of the core; solder a flexible lead on each of the ends. Coil B, is made so as to slide inside of coil A. Mount coil A on a suitable base and place coil B, inside of coil A.

Arrange connections as per diagram. The battery current flows thru the watch-case buzzer and is converted into an alternating current; the buzzer is in series with coil B. The alternating current in coil B induces a current in coil A. The 75 ohm watch-case telephone receiver is fitted with a head-band so as to leave both hands free. The receiver is connected across the terminals of the coil A, and the test terminals are connected in parallel with the receiver. The strength of the sound in the receiver may be varied by moving the coil B, in or out of coil A. The amount of adjustment needed depends upon the size and the style of armature that is under test. One dry cell will operate the set and lasts for months; the writer has his Test Set arranged so that it is very compact, light, and handy. He has a light oak box large enough to hold one dry cell, the receiver with head-band and the test cords. The buzzer, switch, and terminals are all mounted on the inside of the top cover, which is hinged and has a lock on it. The outside is fitted with a leather handle for carrying.

HARD RUBBER FROM BATTERY CELLS.

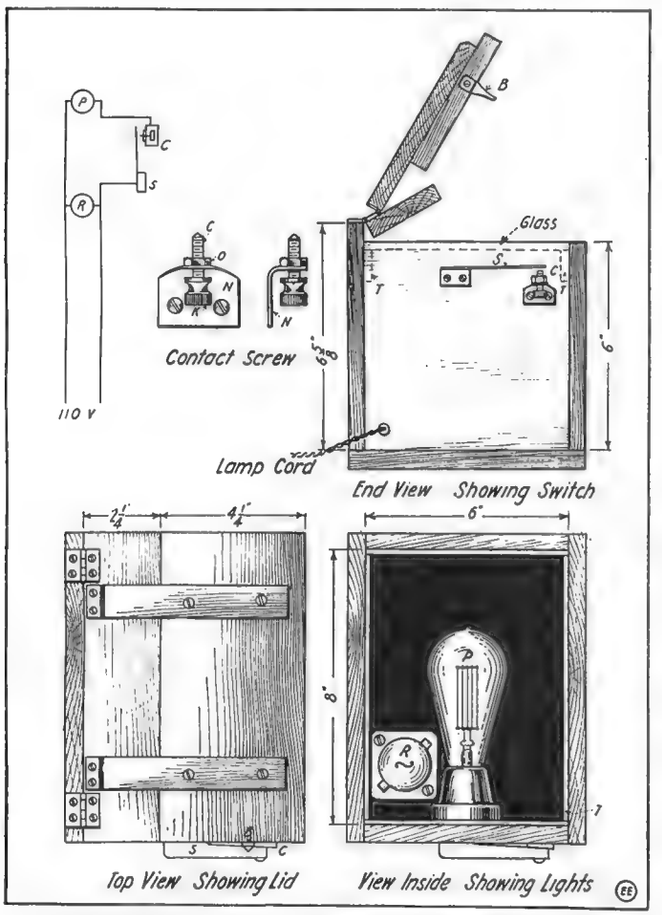
Experimenters residing in towns wherein a storage battery service or repair station is located, need never want for hard rubber sheets 3/16" or less in thickness, such as would be desired for small bases, panel fronts, etc., as the containers from worn out and broken storage batteries, which are made of hard rubber, can always be obtained for the asking, or at the most, for a few cents.

Saw the hard rubber container carefully down thru the corners, then by plunging in hot water it may be bent in any desired shape. If badly warped, place in hot water until it becomes flexible, clamp between two boards while still warm and leave it cool. All hard rubber sheet becomes quite flexible when warmed in a hot water bath but soon hardens when removed.

Contributed by L. HAGERMAN.

A Printing Box for the Amateur Photographer

THERE are few things that the amateur photographer uses that afford more pleasure than a good printer. The one herewith described and illustrated can be easily and economically made and is extremely useful to the amateur who has access to the electric lighting current. By using odds and ends that are usually found around the work shop the total cost of the printer would probably be less than one dollar. The box and lid are made of some soft wood, preferably poplar, one-half inch thick. It can be purchased from a lumber company or if the maker wishes to be economical, store boxes of the right kind of material can be used to a good advantage.



A Clever Electric Printer for Amateur Photographers. Closing the Outer Lid Causes a Switch to be Closed, Lighting the "Printing" Lamp. Raising the Lid Opens the Circuit. The Ruby Lamp Burns Steadily.

The lid is made in two pieces, so that the back piece can be lowered on to the paper and film when they are in place and held firmly until the outer part is lowered. On lowering the outer part and pressing it down firmly, the projecting point B strikes the spring S and forces it down on to the point C, thus closing the circuit and lighting the printing lamp P, as shown in the wiring diagram. The small ruby lamp R, burns all the time. If a small ruby lamp is not available, one can be made that answers the purpose very well by wrapping a small bulb of low candle-power with two or three thicknesses of red crepe paper. In fact the latter is to be preferred, as the intensity of the ruby lamp can be regulated to suit the needs by removing or adding extra thicknesses of the paper.

The under side of the lid is covered with some thin kind of felt, such as a good grade pennant felt or a good heavy grade of canton flannel. This felt should be glued on the lid smoothly in one piece and then cut along the line joining the two parts of the lid with a sharp knife. The glass which is supported by the thin strips T, tacked around on the inside of the box, should be strong and thick, preferably plate glass. If plate glass is not available some good strong window glass will do, care being taken that the bulge of the glass is upward. The spring S is made from a piece of sheet brass. The contact screw C can perhaps best be made from a piece of sheet brass, and a binding post from an old dry cell. The octagonal nut O can be soldered to the brass piece N, while the knurled nut K can be soldered fast to the bolt and the screw C formed by filing off the head. The position of both lamps is shown in the drawing; all the wiring is inside the box. The wires to the spring S and the screw C, can be brought thru the screw holes and thus kept hidden. The length of the lamp cord, which is provided with a plug, can be made to suit the needs of the individual.

The inside should be painted with some good light-reflecting paint, while the outside had best be painted some dark color.

Contributed by JOHN G. ALBRIGHT.

FREAK TROUBLE. TIPS TO "BUG" HUNTERS.

By Thomas W. Benson

Electrical apparatus seems to be subject to more trouble to the square inch than any other class of apparatus. Perhaps this may be due to the fact that I am more acquainted with trouble in this field than in any other, still I feel sure my statement is fairly correct. Common troubles are nothing unusual, but some of the "freak stuff" it has been my pleasure to "shoot" ought to be interesting news to my fellow sufferers.

One of the most puzzling perhaps was the affair of the power circuit that went dead and then alive in turn without rhyme or reason. In a certain plant a number of machines were driven by motors connected to this circuit. Suddenly all the machines would stop and before the electrician could get a test on the entire line the power would come on. This occurred so often and gave rise to so much trouble that the man stayed with a motor till it went dead.

All the fuses were intact, the line fuses and motor fuses, and this was as far as he would get with his test before the power returned. Well, he started to trace out the line, inch by inch, thru floors, across ceilings, clean down to the switch-board without finding a single thing the matter with it. A circuit-breaker was connected in the circuit to protect the fuses on the board. As an after-thought the trouble man remarked to the engineer of the plant:

"Gus, does that breaker ever let go?"

"Oh, yeah, every hour or so. I just slam it in every time I notice it out," was the quiet reply.

There you are. Where can you place the blame?

Then again, a large generator was being overhauled. The armature had been taken out and the fields retaped and painted. The repairman made a ground test with a meter connected to the power mains. And the meter said—*grounded*—perfectly and securely. The connecting wires between each of the fields were removed and each field tested separately. Each and every field coil to all appearances was grounded. Oh, beautiful sight for the junk man.

When,—as a matter of fact all of them were clear. The false meter reading was finally discovered and the explanation was simple as A B C.

The machine made connection to the ground, being in contact with an iron post. One test lead was connected to the center wire of the three-wire power mains. A wire was run from one outside leg to the meter and the other terminal of the meter was connected to the other test lead.

On applying the test leads, the first to the field coil terminals and the second to the frame of the machine, the meter would register full voltage. But the current was not flowing from the field coil into the frame. Oh, no; it was flowing from the outside leg of the mains, thru the meter, into the frame of the machine, thence to ground. The center wire of the system being grounded at the power station resulted in a complete circuit being formed.

Why, even a "Doorbell Engineer" has his troubles. A certain calling system comprising twelve push-buttons, two bells and an annunciator was dead. A test of the batteries showed them rather weak. A set of nice new dry cells was obtained and cheerfully wired into the circuit—but the system remained dead as the proverbial door-nail.

Shunting the master leads behind the annunciator and cutting out the push buttons resulted in a signal at the bells, which indicated that the trouble was between the annunciator and the bells.

The annunciator was examined carefully but everything was in perfect condition. The leads between the annunciator and the push-buttons all tested clear. Where was the trouble?

Briefly, the man who designed the annunciator was at fault. The type used is no doubt familiar to most trouble-men. One board in the back of the apparatus supports the coils and indicators. The back of this board is fitted with a series of springs that push outward and make connection with a number of screws attached to a second board. The wires from the push-buttons are connected to the screws on the latter board. And the whole trouble was caused by the springs not making good contact with the screws. This would not be noticeable because there is no way of determining this fact when the boards are in place except that the device tests open, and when taken apart appears to be all right. Of such things "troubles" are made.

Now let me tell you of the freakiest bit of trouble it has ever been my pleasure to hear of. First let me assure you that the

(*Continued on page 734*)

HOW TO MAKE IT

This department will award the following monthly prizes: First Prize, $3.00; Second Prize, $2.00; Third Prize, $1.00.
The purpose of this department is to stimulate experimenters towards accomplishing new things with old apparatus or old material, and for the most useful, practical and original idea submitted to the Editors of this department, a monthly series of prizes will be awarded. For the best idea submitted a prize of $3.00 is awarded; for the second best idea a $2.00 prize, and for the third best prize of $1.00. The article need not be very elaborate, and rough sketches are sufficient. We will make the mechanical drawings. Use only one side of sheet. Make sketches on separate sheets.

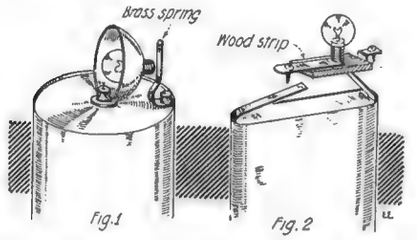
FIRST PRIZE, $3.00

SIMPLE FLASHLIGHT AND BATTERY TESTER.

The illustration, Fig. 1, explains itself. The material for the flash-light was an old reflector, a piece of very thin brass and a 1.5 volt bulb. A hole was bored in the reflector to accommodate the center binding post of the dry cell, and the spring brass strip was cut out and bent to suit. The light can be switched on by pressing the spring against the lamp base.

The "battery and lamp tester" shown in Fig. 2, was made from a broken miniature socket by merely fixing it on to a thin strip of wood and screwing in the right size bulb; a 1.5 volt bulb was used for testing the single cells of tubular batteries and a 3.5 volt lamp for the flat 3 cell, etc. It can also be used for testing lamps.

Contributed by DONALD HOUSTON.



Simple Battery Flash-light and Battery Tester Which Anyone Can Make In a Few Minutes Without Any Tools.

MEASURING SMALL QUANTITIES OF LIQUIDS.

Small quantities of acids and other liquids cannot be accurately measured in a wide glass, while the practise of quoting quantities in "teaspoons" which is still followed by some writers is altogether unsatisfactory. Not only does the quantity of liquid contained by different teaspoons vary, but if the liquid happens to be a strong acid the spoon will be attacked and partially dissolved.

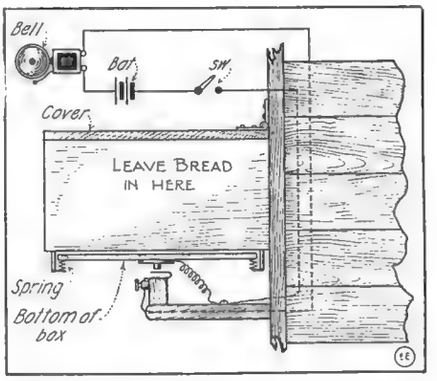
A convenient pipette for measuring small quantities, up to a few cubic centimetres, can be made from a fountain pen filler. Paste a narror strip of paper along the glass tube, making two marks, one just above the tapered end and another near the rubber bulb. By filling the tube up to the upper mark 20 times and emptying into any available graduated measure until the water reaches the lower mark, the cubic capacity of twenty times the length of straight tube between the marks will be found with sufficient accuracy. Dividing this by 20 gives the actual capacity of one length, any error in the original observation having been reduced by division to a practically negligible quantity. It only remains to divide up the space between the two marks so as to show ¼ cb. cm. or .5 cb. cm., and the measure is complete.

Contributed by H. J. GRAY.

SECOND PRIZE, $2.00

LET THE BREADMAN WAKE YOU WITH THIS ALARM.

I herewith submit an alarm system which is very easily constructed and installed. By



With This Simple Alarm Bell Attached to the Bread Box, the Breadman Wakes You on His Morning Round.

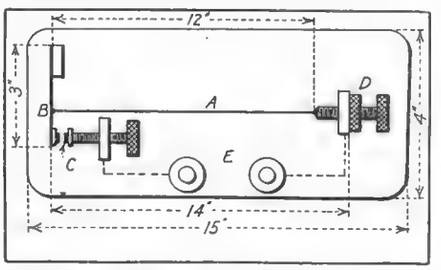
the use of it one can arise every morning at a regular time, when either the milkman or bread-man arrives, or any other form of early delivery.

I noticed in the September edition you considered the Rain Alarm of value, so I thought this form of alarm would meet with the approval of the "E. E." readers.

Contributed by E. T. JONES.

A SIMPLE THERMOSTAT.

Contrary to general practise, in this thermostat the resistance wire itself is the "expanding" unit. The base and supports may be of any insulating material. A, is



A Somewhat Different Thermostat for Amateurs to Make. The Expansion Unit is Made of Wire.

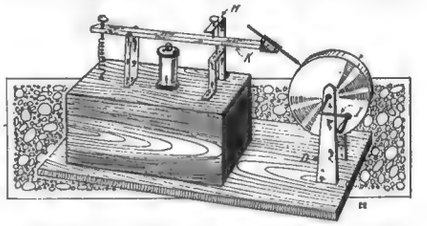
the resistance wire. It may be any kind, even iron. The size required varies for different temperatures. For one or two lamps, Nos. 30 to 32 wire should be used. For 2 amperes No. 28 is right. B, is the brass spring that keeps the wire taut. It is 3" x ½" x 1/32". C, represents the contacts. They are made by cutting off two flashlight battery carbons ⅛" from the brass caps. One should be fastened to spring B, and the other movably mounted on the base. D is the wire adjustment. The bolt slips loosely thru the support. Wire A is fastened to its head. The nut is screwed on the other end for adjustment. E represents the binding posts. Note series connections.

Contributed by CLINTON SIMPSON.

THIRD PRIZE, $1.00

A FOUNTAIN PEN TELEGRAPH RECORDER.

An ordinary telegraph sounder is used to build this recorder with, but the standard H is changed somewhat, as is plainly seen in sketch. To the hammer is attached an extension—K. At the end of K, at the correct angle a fountain pen is fastened so that when the circuit is closed it marks the dots and dashes on the drum J. This is made of a pasteboard tube or a baking-powder can. The drum turns on a brass rod which is supported by standards D. The paper is held on the drum by rubber bands, clips, etc. A handle I is mounted at the end of the rod, to turn the drum. By turning the handle slowly, a fairly long message may be recorded, and by mounting the drum on a threaded rod, so as to make it move from left to right, as it rotates, a very lengthy



A Telegraph Recorder Made From an Old Sounder and a Fountain Pen.

message can be recorded. It is a simple matter to rig up this drum to be driven by a spring or electric motor.

Contributed by CHARLES FRANK.

A GOOD DIELECTRIC FOR A FIXT CONDENSER.

Paper is some times not entirely satisfactory for condensers. Owing to this fact I got to looking for something else and ran across three old pieces of photographic film which had been spoiled in the making. A condenser made from it and some tinfoil proved entirely satisfactory in every way.

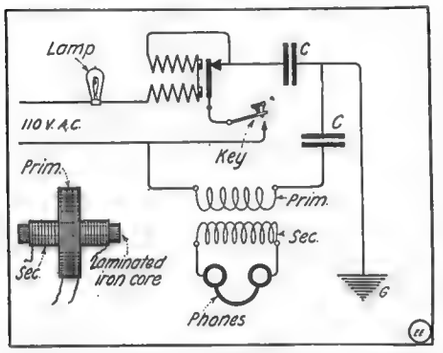
Contributed by T. S. LIVELY.

EXPERIMENTERS!!!

Don't forget to write up that little "stunt." It may win a prize. Address all manuscripts to the Editor, Electrical Experimenter, 233 Fulton Street, New York City.

IMPROVED NON-RADIO SIGNALING SCHEME.

After having experimented a while with my non-radio communication set, I have devised a new scheme for receiving; it both amplifies and protects the 'phones against damage from the 100-volt circuit,



The Radio Amateur Will Find of Interest This Improved 110-volt Buzzer System for Short-Range "Non-Radio" Communication.

should the condensers become punctured. It also brings into use apparatus or parts of the same which are on the shelf, due to the ban on the amateurs by the Government.

As you will notice where the 'phones were connected I have inserted what I may call the primary, which is composed of about 100 turns of No. 22 S.C.C. magnet wire on a laminated core. Over this, after insulating it well I take an old secondary unit of my transformer and place it in the middle of the primary winding on the core. Now we have what I might call a small open-core transformer. This as you will notice protects the 'phones as they are now bridged across the secondary and are inductively connected to the power line. It also amplifies the signals.

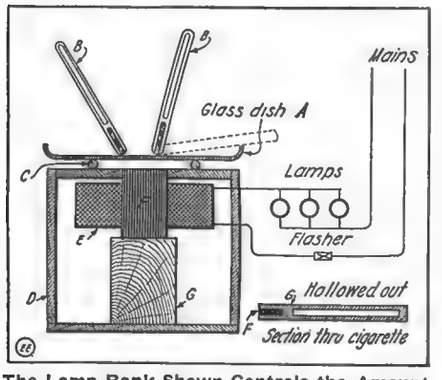
Contributed by E. T. JONES.

HOOK-UP CORRECTION

While looking thru the September issue of THE EXPERIMENTER, I noticed a mistake.

On page 327, the article, "A Home-Made Magnetic Window Attraction," it says that the lamps should be connected in series with the electro-magnet, but the diagram shows them connected across the main line. In this way they would have no effect on the magnet whatever and fuses would be blown every time the magnet was connected.

Contributed by GUY A. KENNEDY.



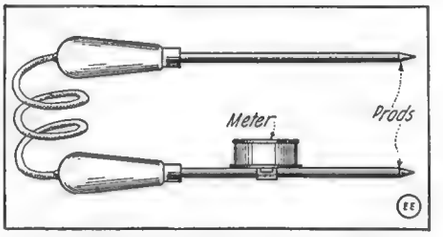
The Lamp Bank Shown Controls the Amount of Current Thru the Magnet Coil. The Flasher Opens and Closes the Circuit, Causing the Cigarettes to Dance.

TAKING STORAGE BATTERY READINGS.

The voltage of a storage battery is a fair indication of its condition. Faulty cells in a series of batteries can be detected by taking individual voltage readings of the cells.

A device that makes these tests easy when a large number of cells has to be tested is shown in the illustration. Two iron rods, 12 inches long and ⅜ inch in diameter are pointed at one end and fitted with wooden handles at the other end. A small voltmeter, with a scale reading 0-3 volts in 10ths is mounted on one rod near the handle. One terminal from the voltmeter is connected to the rod on which it is mounted, while the other terminal is connected to the other rod by means of a two-foot length of flexible lamp cord. The rods should be well taped to prevent them short-circuiting any cells should they accidently come in contact with the terminals.

To take readings on the cells the load *must be switched on* and then by forcing the points of the iron rods into the soft lead of the binding posts on the cells the voltage can be read. A cell showing less than 1.7 volts should be charged separately until up to the voltage of the other cells in the set. No reading or a reverse reading



A Good Place for the Voltmeter in Battery Testing Is on One of the Test Prods.

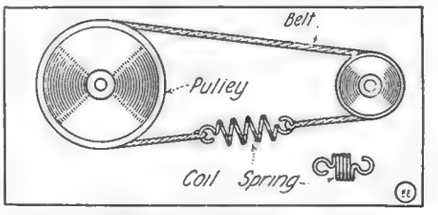
indicates a shorted cell. This should be removed and examined for the trouble.

It is well to take hydrometer readings on storage cells at regular periods and to examine the height of the solution, keeping it at all times about one inch above the plates.

Contributed by THOS. W. BENSON.

SPRING DEVICE FOR TIGHTENING BELTS.

For those who experience annoyance from slipping of leather belts on static ma-



A Spiral Spring Forms an Ideal Automatic Belt-Tension Adjuster.

chines, I would suggest that they connect the ends of the same by a small coil spring, (see Fig.), such as can be easily procured from a typewriter or purchased at any hardware store for a few cents a piece. This will serve to take in whatever slack there may be and thus keep the belt at an even tension when revolving.

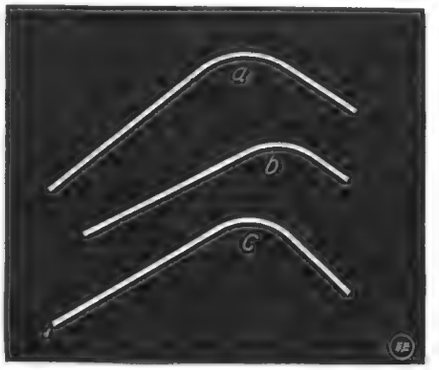
Contributed by JOHN T. DWYER.

MAKING FRENCH CURVES FROM COPPER WIRE.

Here is an efficient substitute for the French curve. I often have occasion to plot curves for efficiency, watt loss, terminal volts, etc., and find they do not bend much. The curvature of the average French curve is too great. So I stript the insulation from a 12 inch piece of B. and S. No. 6, soft drawn copper wire, being careful not to injure its surface. Laying it on a flat surface I approximated the general shape of the curves shown and used it as a French curve.

It is superior to the French curve also, because if the ink runs to the ruling edge its shape prevents the ink reaching the paper and smearing. Hence work may be done quickly and neatly.

Contributed by ROBERT VALVERDE.



"French" Curves of Various Intricate Shapes are Easily Made from Heavy Copper Wire.

A GOOD CLEANING SOLUTION FOR GLASSWARE.

A good cleaning solution (chromic acid) may be made by dissolving potassium or sodium chromat in concentrated sulfuric acid, until a saturated solution results. Apparatus to be cleaned should be covered with a thin layer of this solution, and rinsed with water.

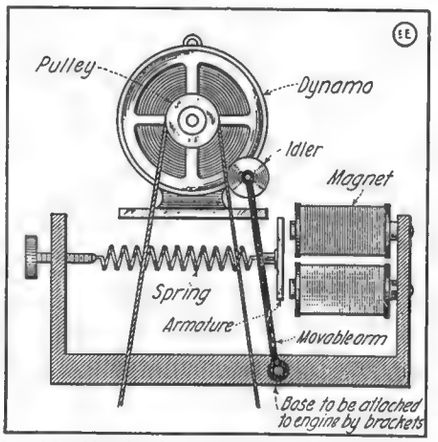
Contributed by H. C. KIHLSTROM.

A BELT "GOVERNOR" FOR REGULATING AUTO DYNAMOS.

It is a well known fact that a small dynamo connected direct to an automobile motor, without a governor of some kind, will burn out its armature or the lights with which it is connected, due to the rise of the voltage when the motor is speeded up.

The accompanying illustration shows a device which prevents this and answers all the purposes of a speed regulator. An idler pulley mounted on a movable arm, controlled by an adjustable spring, furnishes the necessary tension to the belt driving the dynamo. A flat iron armature mounted on the opposite side of the movable arm is controlled by an electro-magnet wired in series with the dynamo and lights.

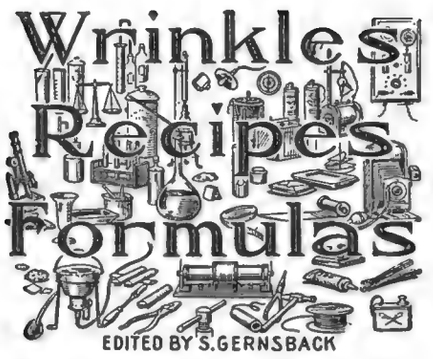
As the current increases the magnet



In this Simple Auto Dynamo Governor the Variations of the Current Act Thru an Electro-Magnet to Regulate the Belt Tension by Means of an Idler Pulley.

draws the idler back and allows the belt to slip until the dynamo speed returns to normal.

Contributed by HARRY R. WHITEHEAD.



Under this heading we publish every month useful information in Mechanics, Electricity and Chemistry. We shall be pleased, of course, to have our readers send us any recipes, formulas, wrinkles, new ideas, etc., useful to the experimenter, which will be duly paid for, upon publication, if acceptable.

EXPERIMENTERS' APHORISMS

In the following, we wish to give to the Experimenter some hints as to the use of the different ingredients and how to work them:

(1) Always bear in mind that exact working of a formula requires ACCURACY, CLEANLINESS, PATIENCE, and SKILL.

(2) Know what you are about, before you start to experiment.

(3) "THE HISTORY OF FAILURES IS THE HISTORY OF SUCCESS" goes an old adage, and it applies well to the experimenter.

(4) Many times impure, wrong or deteriorated raw materials, spell FAILURE instead of SUCCESS.

(5) A great many of the chemicals and ingredients required, cannot be obtained from drug stores; buy them at a reputable supply house.

(6) BEFORE CONDEMNING A FORMULA, be sure the fault does not lie with the manner of handling it, or the purity of the ingredients.

(7) Be sure to mix the materials comprising a certain formula in the proper sequence.

(8) When starting to prepare a mixture, especially one containing liquids, ask yourself: "IS THE SPECIFIC GRAVITY CORRECT, AS INDICATED BY A HYDROMETER? IS THE TEMPERATURE RIGHT? IS THE QUANTITY OR WEIGHT RIGHT?

(9) Acids and water, when mixed, should be manipulated in the proper manner, i. e., THE ACID SHOULD BE POURED INTO THE WATER, and not vise versa, as the solution is liable to be forcibly ejected from the containing vessel and into the mixer's face.

(10) For any kind of SYSTEMATIC WORK, a floating THERMOMETER and HYDROMETER, as well as measuring glasses and scales, should always be provided, as GUESSWORK is EXPENSIVE, and SOMETIMES FATAL.

(11) Put labels on ALL bottles, boxes and packages with FULL INSCRIPTION as to their contents, it will avoid troubles and mistakes.

(12) Remember that a beginner cannot expect to make articles AT FIRST, which will compare with regular manufactured products.

METALLIC TREES.

To make a silver tree, dissolve two ten-cent pieces in 2 fluid drams (about a dessertspoonful or two teaspoonfuls) of concentrated nitric acid, evaporating nearly to dryness to drive off excess of acid (evaporate by holding solution over a flame). Cool, and dissolve the resulting crystalline salts in sufficient distilled water to make a saturated solution. This solution will be slightly blue on account of the copper which is alloyed with coin silver. Place the solution in a glass vessel having a curved bottom. Add a drop of mercury the size of a large pea and set aside for a day. A large growth of mercury and silver amalgam will be produced which may be kept indefinitely.

To make a lead tree, place in a tall jar (a quart preserving bottle will answer the purpose) a solution made by dissolving 4 ounces of lead acetate in one quart of water. Place the bottle where it will not be subject to vibration and suspend in it a strip or cylinder of zinc; battery zinc will answer the purpose very well. An abundant growth of crystalline spangles will collect on the zinc within ten days.

To grow a tin tree, dilute commercial tin chlorid solution with forty times its bulk of water and proceed the same as when making the lead tree.

Contributed by ALBERT W. PUTLAND.

MARKING POISON BOTTLES.

A very convenient way to mark bottles containing poisons so that they can readily be distinguished in dark rooms or closets

Take a Disc of Sand-paper or Emery Paper and Glue It on Top of Your Poison Bottle Cork—a Cheap Yet Efficient Marker Which You Can't Miss in the Dark.

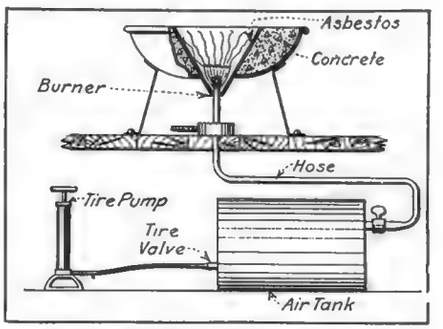
is to cut a piece of heavy, coarse sand-paper the size of the top of the cork and paste or glue the piece on the top of the cork or stopper of the poison bottle. As one's hand invariably comes in contact with the top of the cork in opening a bottle, this simple device will prevent mistaking a bottle containing poison for another.

Contributed by J. EDWARD WHITE.

A SMALL FORGE FOR THE AMATEUR.

While engaged in some experimental work at home, I needed a small forge, and proceeded to make one myself. Its construction is very simple. An old granite basin from the sink was filled with cement and a hole left for the fire box. While the concrete was still damp a sheet of asbestos was laid around the inside. This is to keep the heat in. A small tin funnel was put on the inside and the spout arranged to stick out underneath. Some rubber tubing was connected to this and thence to an old gasoline tank under the table thru a stop cock to regulate the flow of air. The other end of the tank was fitted with a tire valve and an ordinary tire pump connected up as shown. Charcoal or coke may be used in this furnace.

Contributed by M. C. CAMPBELL.



Here Is a Way to Make a Handy Forge for Amateur Shop-work.

HOW TO FROST OR COLOR LAMP BULBS.

Dip the bulb in a thin solution of white shellac and alcohol, which gives it a frosted appearance. Add diamond dyes of the desired shade to the solution for colors.

Contributed by WADE ROBINSON.

AMATEUR "KNICK-KNACKS."

THIEF CATCHER—Last summer we were bothered by nocturnal cherry thieves. So I contrived a trap by annealing one end of a clock spring and puncturing it with two screws. I next screwed it to a wooden base so that the free end clamped to the base with a little pressure. I then screwed a piece of metal on the base so that the spring rested on it. The spring and metal were connected so as to close a bell circuit. A small block of non-conducting material was placed between the spring and metal contacts and a thread tied around the block, so that the pulling of the thread would pull the block out and cause the circuit to be closed. The thread encircled the tree and the thief walking into it rang the bell. This device costs practically nothing and may save many dollars worth of fruit or poultry.

INK THINNER—If your drawing ink clots or gets lumpy from standing open, add some aqua-ammonia and shake well.

DRAWING CLEANER—When your drawing-board or drawing becomes dirty from grafite and finger marks, etc., it may be cleaned by rubbing with stale bread. Wall paper may be cleaned the same way.

CLEANING BLACKBOARDS—A little "3 in 1 oil" or similar oil on a rag will free blackboards of chalk.

KEROSENE TORCH—By placing a blotter in a bottle partly filled with kerosene and lighting the protruding end, one has a good improvised light or stove.

Contributed by EMERSON ESTERLING.

HOW TO PREPARE PURE SILVER FROM COIN SILVER.

Silver coins are not pure silver, but contain copper to make them harder. Canadian silver coins contain 925 parts of silver and 75 parts of copper to each 1000 parts, and the metal is called Sterling Silver. United States silver coins contain 900 parts silver and 100 parts copper to each 1000 parts, and the metal is called "900 fine."

In order to prepare the pure silver and to get rid of the copper, a silver coin is dissolved in dilute nitric acid (HNO_3). The solution is then diluted with hot water to 200 or 300 cubic centimeters (approximately 7 or 10 ounces). To this add a solution (hot) of sodium chlorid (common salt) which will throw down an insoluble precipitat of silver chlorid. Wash the precipitat thoroly by decantation; that is, by successively pouring on hot water and allowing the precipitat to settle, then pouring off the clear liquid. After a thoro washing in this manner, filter the solution thru filter paper and dry it carefully in warm air. Remove the precipitat from the filter paper and place it in a porcelain crucible. Heat gently with a small flame until the silver chlorid is melted then let it cool.

Cut out a piece of sheet zinc large enough to cover the bottom of the crucible and lay it on the silver chlorid. Now add a little water and a few drops of dilute sulfuric acid (H_2SO_4) and let the whole stand for twenty-four hours. The silver chlorid will be reduced to silver and zinc chlorid is formed. Take out the piece of zinc and wash the silver with a little dilute sulfuric acid and then with water. This finely divided silver may be fused in a crucible by drying it and mixing with half its weight of sodium carbonat and apply sufficient heat.

Contributed by D. J. THOMSON.

[Ed. Note: There is a statute law against destroying or mutilating U. S. money.]

Experimental Chemistry

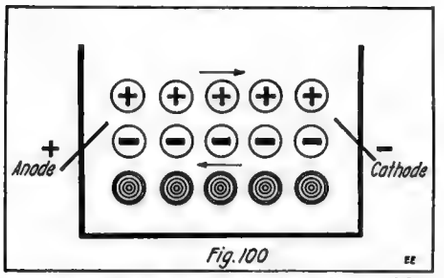
By ALBERT W. WILSDON

Twenty-first Lesson

ELECTRO-CHEMISTRY

LAWS AND CONDITIONS

WITH the aid of the induction coil spark, or electric arc, chemical combination as well as decomposition can be produced. But the Galvanic current induces chemican decomposition only. Decomposition



Illustrating Ions and Molecules: Upper Line + Ions; Middle Line — Ions; Lower Line Undissociated Molecules. Arrows Indicate Direction of Anions to Anode and Cations to Cathode.

which is caused by the galvanic current is termed *electrolytic decomposition,* which operation is termed *electrolysis.* All substances do not conduct the electric current, and for this reason they are classified as follows:

1. *ELECTROLYTES,* which are substances which quite readily conduct electricity, and,

2. *NON-ELECTROLYTES,* which conduct it with great difficulty, or not at all. Each of these divisions may be classified as follows:

Electrolytes of the first class, these usually being metals, such as silver, copper, platinum, etc. These may be in any convenient form as sheets, wires, etc.

Electrolytes of the second class, are generally acids, bases and salts, either fused or in solution. We shall chiefly deal with this class.

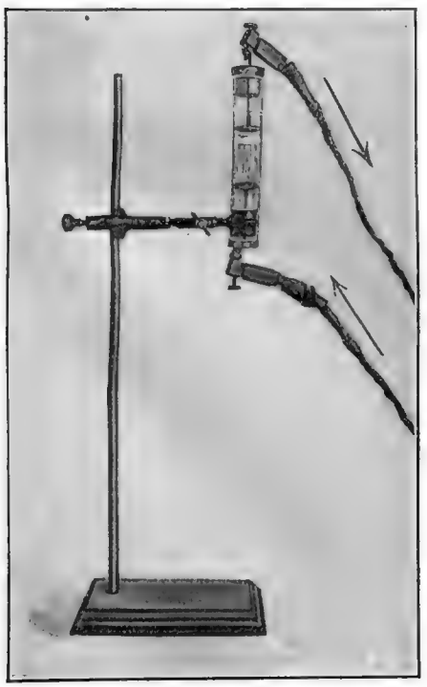


Fig. 102. Photo of Actual Apparatus Set Up for Experiment With Migration of Ions.

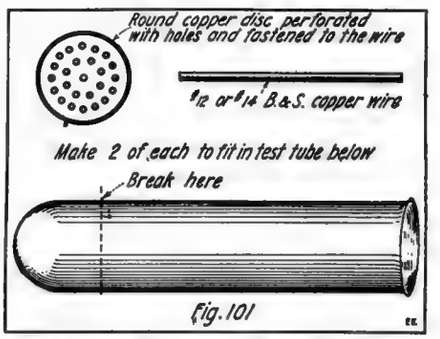
Non electrolytes of the first class, may be illustrated by such substances as rock salt, and solid salts generally, which resist an electric current, tho in some cases they are melted by the current and thus become electrolytes.

Non-electrolytes of the second class are liquids, or substances in solution or fusion that offer great resistance to the current, or if they conduct at all, very slightly.

The wires which carry the current into and out of the electrolytes are called the *electrodes.* There must be two electrodes in order that electrolytic action take place, one of these, the positive (+) carries the current into the electrolyte and is called the *anode,* while the other carrying the negative current (—) is the *cathode.*

THE IONIC THEORY:

We now approach a new phase of a solution. When an electrolyte of the second


Round copper disc perforated with holes and fastened to the wire
#12 or #14 B.&S. copper wire
Make 2 of each to fit in test tube below
Break here
Fig. 101
EE

Details of Electrolytic Apparatus Shown in Photo Fig. 102.

class is dissolved in a solvent like water, a certain amount of it is believed to be dissociated or broken up into its *positive* and

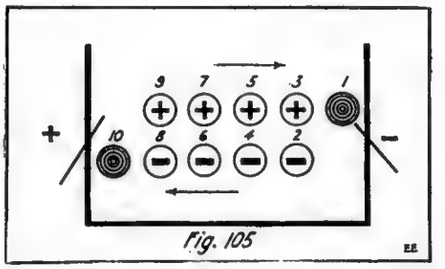


Diagram Showing Ions in Motion Under Effect of Electric Current. Atoms Are Formed in This Process.

negative constituents. When sodium chlorid (common salt) dissolves to saturation in water, a certain portion goes into solution without being broken up into its elements or having the size of the molecule changed; but a certain other large part splits up into sodium ions which are charged with *positive* electricity, and chlorin *ions,* charged with *negative* electricity, which exists intermingled in the solution with the undissociated sodium chlorid molecules. In the same way, when silver nitrat ($AgNO_3$) is dissolved, a portion is broken up into silver (Ag) ions and NO_3 ions. The process is called *ionization.* Fig. 100 may represent ionized and non-ionized particles of NaCl. We have seen that elements and compounds of an opposite nature attract each other more than those of like properties; metals have affinity for non-metals, acids for bases. In a similar way *opposite* electricities attract, and vice versa; like repel like, or, put in another way, substances charged with negative electricity are attracted to the positive electrode, or anode, and those with positive electricity to the negative electrode, or cathode. Thus metallic or positively charged ions are attracted to the cathode and non-metallic or negatively charged ions to the anode, whenever a current passes

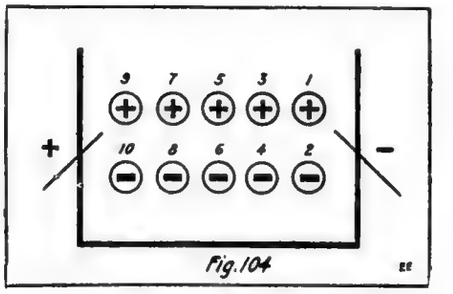
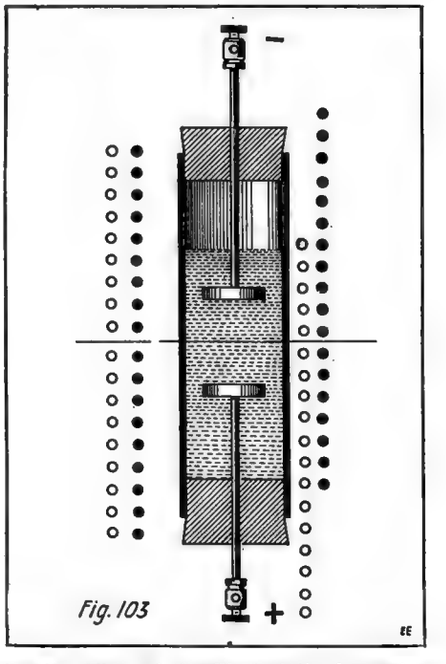


Diagram Representing Ions At Rest In Solution; each + Ion Balanced By a — Ion.

thru an ionized solution. This is a modification of Faraday's theory of direction of current.

An *ion* is, by derivation, a traveler. During the passage of a current those ions that travel towards the anode are called *anions* or upward travelers, those moving to the cathode are called *cations* (or Kations), or downward travelers (see Fig. 100). Anions are, therefore, metallic or *minus* ions, while cations are metals or *plus* ions, their destination giving the prefix of their names. These terms were assigned by Faraday about 1833. He thought the electric current produced the ionization, but Arrhenius, a Swedish chemist, in 1887, announced the present theory, namely, *that the act of dissolving an electrolyte produces the ionization,* and that the current, whenever it is applied, simply sets the ions in motion toward their respective electrodes. On arrival there, they part with their charges of electricity and become atoms or atomic groups (radicals and molecules).

(*Continued on page 724*)



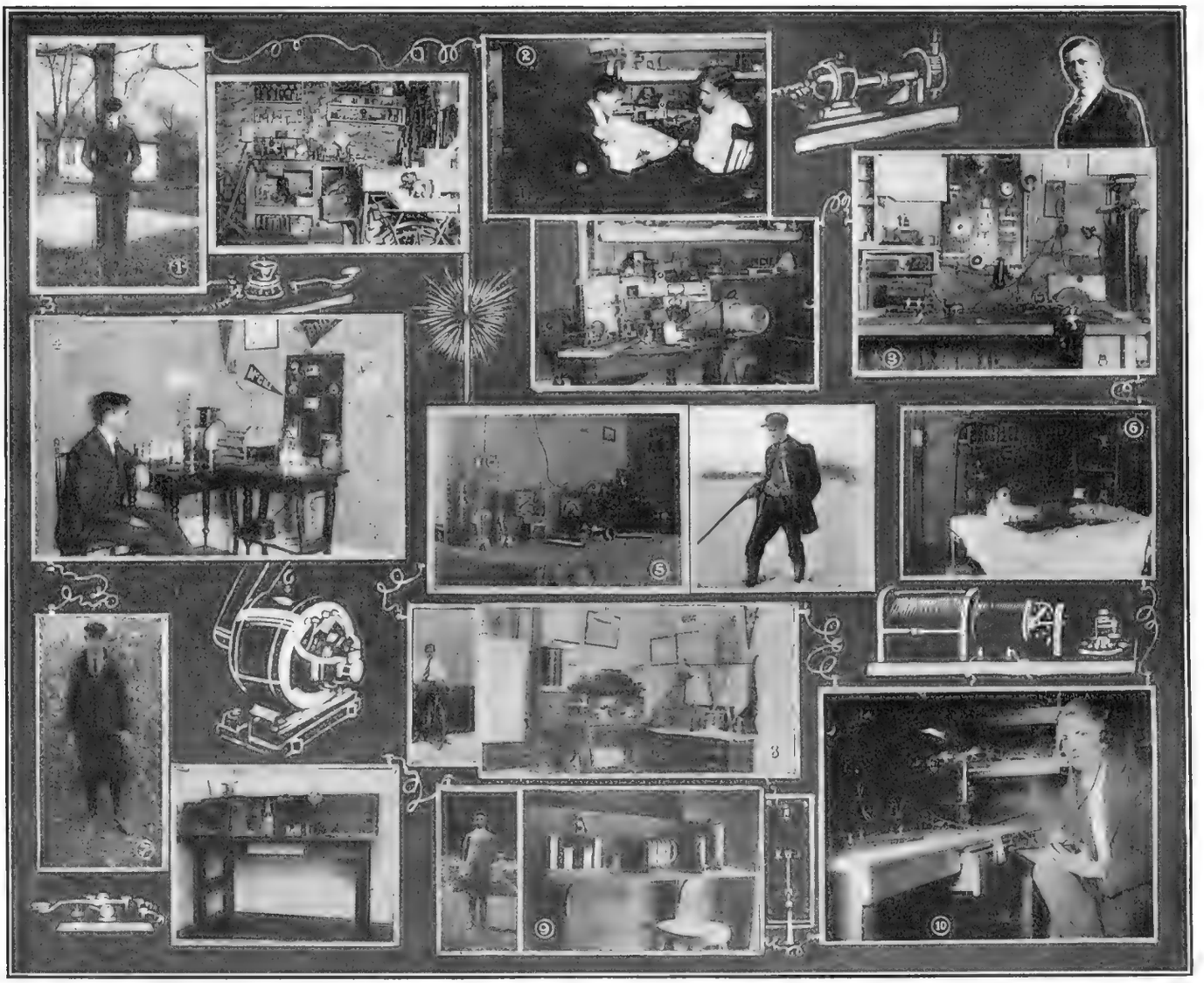
Another View of the Electrolytic Apparatus Illustrated in Fig. 102, With Schematic Arrangement of the Ions At Each Electrode.

WITH THE AMATEURS

Our Amateur Laboratory Contest is open to all readers, whether subscribers or not. The photos are judged for best arrangement and efficiency of the apparatus. To increase the interest of this department we make it a rule not to publish photos of apparatus unaccompanied by that of the owner. Dark photos preferred to light toned ones. We pay each month $3.00 prize for the best photo. Make your description brief and use only one side of the sheet. Address the Editor, "With the Amateurs" Dept.

"Electrical Laboratory" Contest

In the March issue we will publish an interesting story with a number of interesting photos, describing one Amateur Electrician's experimental laboratory. Now "Bugs"—we want to publish a similar article each month. Here's our proposition: Why not write up your "Electrical Lab.," in not more than 500 words. Dress it up with several good clear photographs. If we think it good enough we will publish the article in display style and pay you well for it. The remuneration for such articles will range from $5.00 to $10.00. And "Bugs"—don't forget to make your article interesting. Don't write—"I have a voltmeter, an ammeter, a switchboard," etc., *ad infinitum*. For the love of Pete put some punch in it! Tell us what you do with your instruments and apparatus. You don't mean to tell us that every Experimenter does exactly the same thing. "We" know different—but from the general run of such articles which we have received in the past, one would naturally think every "Lab.," exactly alike. Remember—send a photo of YOURSELF along. Typewritten articles preferred. Tell us the facts and don't send in photos smaller than 3¼" by 4¼". They must be sharp and clear—not veritable "picture puzzles." We can read—but we are not mind-readers. Address the Editor "With the Amateurs Prize Contest."



A GROUP OF REPRESENTATIVE AMERICAN AMATEUR LABORATORIES.

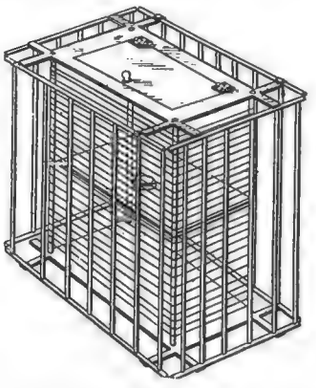
Electrical Laboratories of, 1—Phil Krippner, Green Bay, Wis.; 2—Frank Sloan, San Diego, Calif.; 3—Raymond E. Snyder, Akron, Ohio; 4—J. Hustic Holden, Westmount, Que., Can.; 5—Herbert M. Maus, Milton, Pa.; 6—R. E. Breunig, Chicago, Ill.; 7—Hugh Stevenson, Rochester, N. Y.; 8—D. Kenneth Auck, Bucyrus, Ohio; 9—Harold H. Wilson, Silver Creek, N. Y.; 10—Everett E. Twombly, Pasadena, Calif.

LATEST PATENTS

Electric Fly Trap

(No. 1,247,488; issued to William A. Bass.)

An improvement in electric fly traps which provides an outer pro-

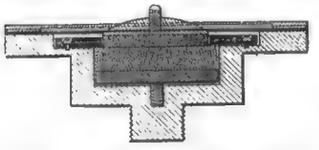


tective cage designed to prevent anyone from getting in contact with the live wires of the inner cage, in the manner shown. There is also provided an electric light either in the lower or upper compartment of the fly trap, to attract the flies or other insects. This lamp is connected in the circuit with the alternately charged wires of the inner cage, and these wires are spaced the proper distance so that an insect or fly passing betwen them will touch both wires, and thus be electrocuted.

New Microphone

(No. 1,245,218; issued to Felix Gottschalk.)

An improved form of electric microphone for telephonic and other purposes, comprising a movable

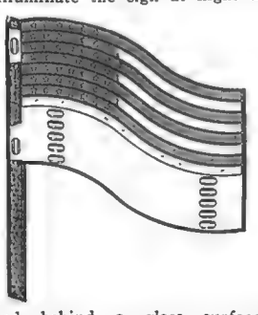


front electrode which is attached to the center of a vibrating diafram in the usual manner, and so arranged in the opening provided in a circular template, that the carbon granules in the cup chamber cannot in any way get out of this chamber, and thus cause rattling or other noises in the microphone. Also a perfect contact with the inner face of the vibrating electrode is provided for, without interfering with the free movement thereof.

Electric Flag Sign

(No. 1,246,847; issued to Paul J. Berg.)

A clever elctrical flag sign device adapted to be made in such a way that it will present an attractive appearance either in the day time or at night. The electric lamps used to illuminate the sign at night are

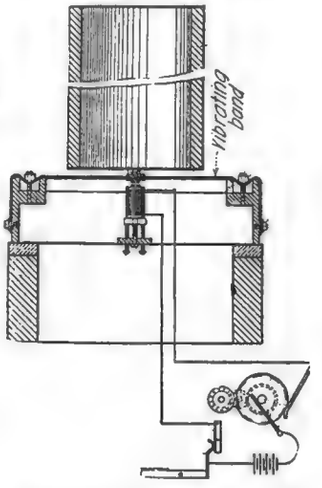


placed behind a glass surfaced, ridged field, provided with the desired surface-coloring on the glass either by incorporating the color or colors in the nature or construction of the glass or by application of stain to the glass. Each of the lamp tubes used in this device contains a multiplicity of filaments regularly spaced and by the special means of construction here employed for obtaining the color effects, etc., the location or shape of the incandescent filaments are not discernible.

Electric Musical Instrument

(No. 1,245,517; issued to Harold Sculerud.)

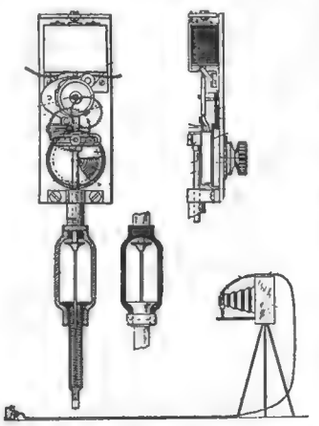
An improved musical instrument which is said to be free from ob-



jectionable harmonics when the special tension band in the instrument is vibrated electro-magnetically by the means shown in the drawing. A sonorous body in the form of a sheet metal band is mounted upon a stiff frame or support, and beneath this band there is placed a suitable electro-magnet connected with the proper circuit interrupting devices, including a battery and controlling key similar to that on a piano.

Electric Camera Shutter Trip

(No. 1,247,902; issued to Karl W. Thalhammer.)

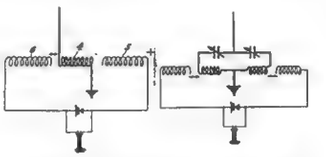


The inventor here provides a suitable device for actuating the camera shutter in any manner desired, the shutter trip being controlled by a reciprocating shaft driven by means of a spring motor on the device. This spring motor is released or retarded by an electro-magnet connected with a portable battery and push button. The battery and control button may be placed at any distance desired from the camera. The outfit is light and unobtrusive, and may be readily carried in the coat-pocket.

Radio Telegraph and Telephone Receiver

(No. 1,245,266; issued to Grenleaf Whittier Pickard.)

This patent provides a simplified form of radio telegraph and tele-

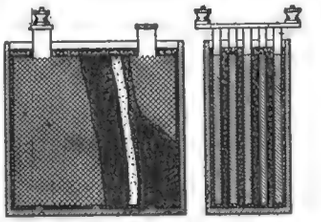


phone receiver having an inductance connected between the aerial and ground in the manner indicated, and which is caused to transfer the oscillatory energy in the antenna circuit to two secondary inductances, connected in a unipolar manner to a crystal or other detector shunted by a sensitive telephone receiver. Secondary coils 5 and 6 are connected together and are wound in such directions that their outside ends are of opposite potentials.

Storage Battery Construction

(No. 1,246,595; issued to Harry S. Hawkins.)

In assembling the cells, plates are spaced about 1/6 of an inch apart, and the inventor then places in the assembled battery a sufficient quantity of granulated sugar to approximately one-fourth fill the spaces between the spaces and around them. After the cell has been assembled

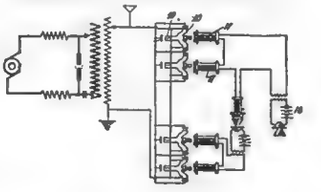


in this manner, it is placed in an oven and baked at a temperature of 380 to 410 degrees Fah., for from three to six hours. During the baking operation the sugar is completely fused and flows about and over the plates so as to completely surround them.

Wireless Telephone Modulator

(No. 1,246,420; issued to Paul J. Hackett.)

The aerial and ground terminals from oscillation transformer are connected to a series of one or more specially devised air-gap condensers. Each condenser unit is actuated by an ordinary telephone or other receiver, which receivers are connected up with a special high-power microphone apparatus in the manner shown in diagram. It will thus be understood how one voice or source

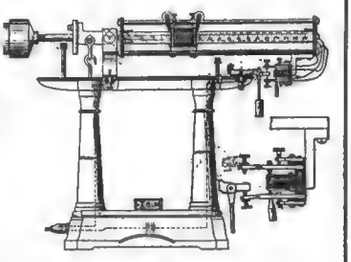


of sound waves talking into the transmitter (18) will actuate a plurality of receivers (17), each of which actuates a four-diafram air-gap condenser (10), thus greatly increasing the strength of the sound waves before applying them to the condenser units.

Electric Automatic Scale

(No. 1,248,273; issued to Samuel G. Crane.)

One of the objects of this invention is to provide an automatic scale with electrically-actuated poise mechanism, whereby the weight of an article or articles placed upon the scale platform is offset and indicated by an automatic movement of the poise along the scale beam. The device is arranged with a pair of electro-magnetic solenoids which may travel along the scale beam and be automatically governed and controlled by the balance weight at the end of the beam by means of special contacts arranged at that point. This electric scale operates on a very unique principle, viz., that whenever

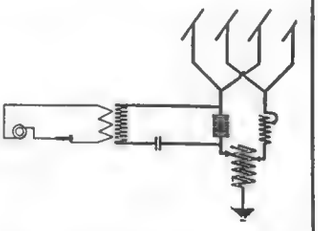


a solenoid coil is energized, it will attract a movable core or be attracted by a fixt core if the coil is movable; also the core and the solenoid will be moved relatively to each other until the center of mass of the core and solenoid coincide. By making the scale beams of tapering magnetic material so as to bring their centers of mass adjacent to the ends thereof, each solenoid is thereby provided with a separate core, and the solenoids being connected together to act as a single poise, will move along the scale beams in a forward or reverse direction when one or the other of the solenoids is energized.

Radio Oscillator

(No. 1,246,626; issued to David G. McCaa.)

This idea provides for an improved radio oscillation generator and radiator by virtue of increasing the energy storage function of the elevated conductors in the open oscillatory system. The idea also covers a system of producing sustained oscillations of low decrement and of emitting electro-magnetic waves



having good tuning qualities. As indicated there is provided an auxiliary grounded conductor parallel to and intermeshing with the main antenna conductors and helix, the inventor having found that it is thus possible to transfer the energy in the spark-gap-aerial circuit to the auxiliary tuned circuit, and in this way to store much greater energy and to radiate the same than without such an arrangement. When a maximum current is radiated in the auxiliary antenna circuit, the spark-gap-aerial circuit shows a minimum of current, and vice versa.

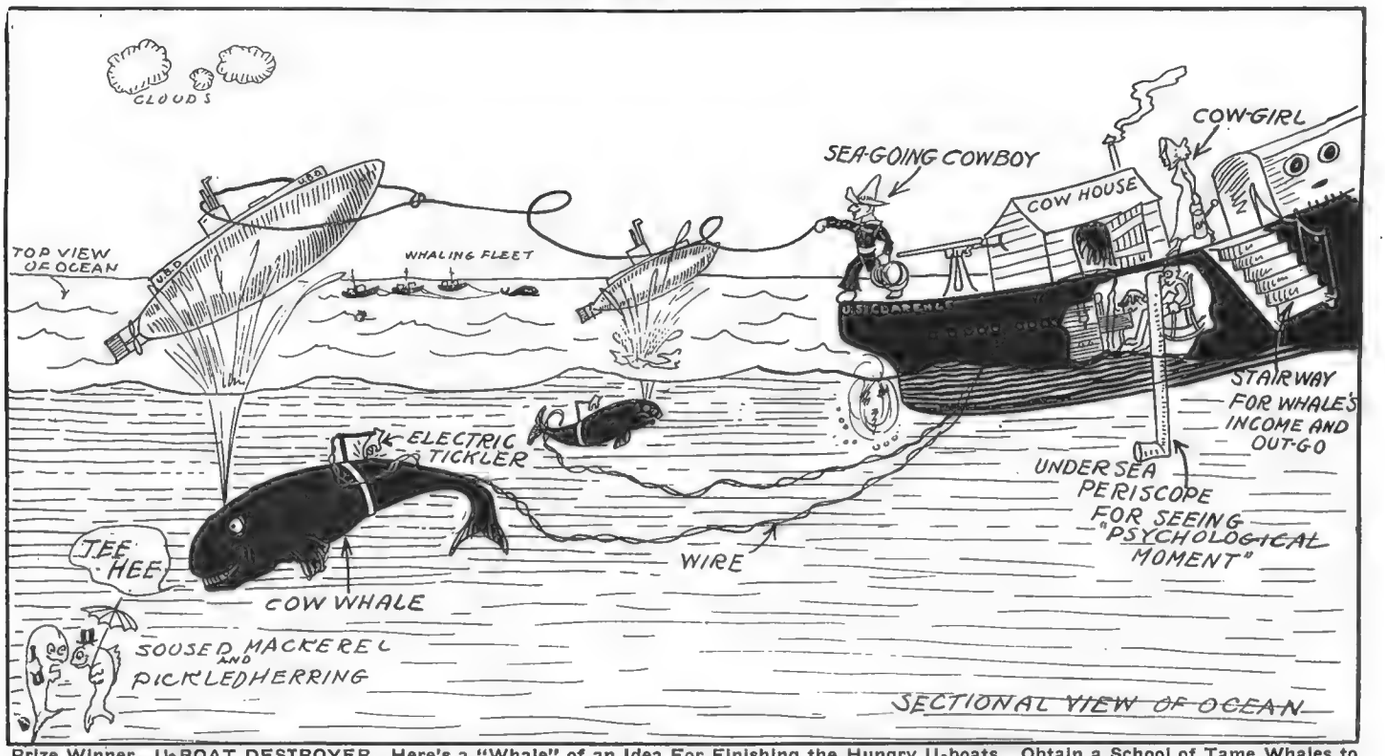
COPIES OF ANY OF THE ABOVE PATENTS SUPPLIED AT 10c EACH.

Phoney Patents

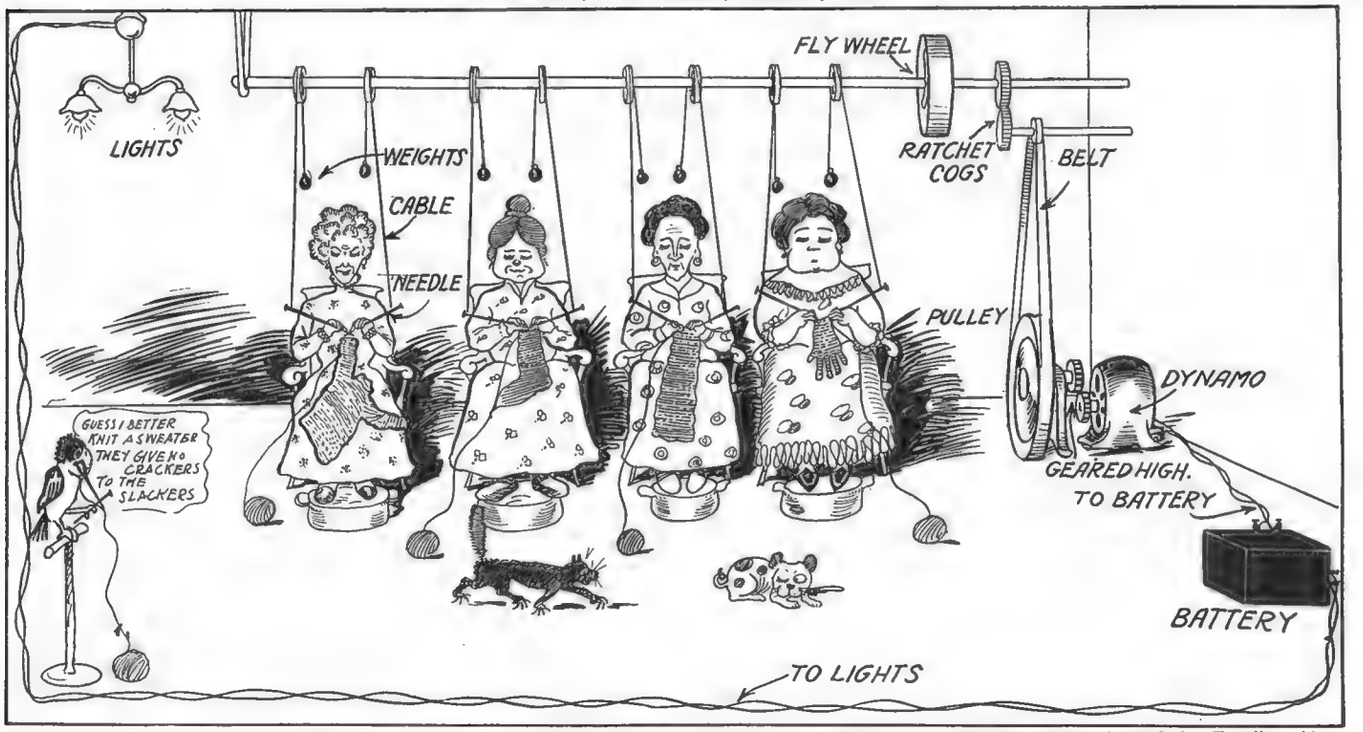
Under this heading are publisht electrical or mechanical ideas which our clever inventors, for reasons best known to themselves, have as yet not patented. We furthermore call attention to our celebrated Phoney Patent Offizz for the relief of all suffering daffy inventors in this country as well as for the entire universe.

We are revolutionizing the Patent business and OFFER YOU THREE DOLLARS ($3.00) FOR THE BEST PATENT. If you take your Phoney Patent to Washington, they charge you $20.00 for the initial fee and then you haven't a smell of the Patent yet. After they have allowed the Patent, you must pay another $20.00 as a final fee. That's $40.00! WE PAY YOU $3.00 and grant you a Phoney Patent in the bargain, so you have $43.000!! When sending in your Phoney Patent application, be sure that it is as daffy as a lovesick bat. The daffier, the better. Simple sketches and a short description will help our staff of Phoney Patent examiners to issue a Phoney Patent on your invention in a jiffy.

PHONEY PATENT OFFIZZ



Prize Winner. U-BOAT DESTROYER. Here's a "Whale" of an Idea For Finishing the Hungry U-boats. Obtain a School of Tame Whales to Convoy Our Troop-ships to France. When a Flock of "Subs" Are Located, Chase the Whales Over-board; When Under the Sub-sea Fighter, the Commander of the Whale-boat Presses An Electric Button. The Electric Tickler Attached to Each Cow Whale Tickles Her; She Becomes Peevish—"Blows"—and Up Comes the U-boat, Which Is Lassoed By the Ever-watchful "Sea-going Cowboy"! That Sounds Simple; Doesn't It? Inventor, J. W. Hanson, Roseville, Calif.



ELECTRIC KNITTING ECONOMIZER. Mother Knits; Sister Knits; Wife Knits; and Several Dozen Other Branches of the Family. Have You Ever Sat and Wondered Just How Much Energy Is Expended By the Female Knitting Element of Our Population? It Would Amount to Over 1,000,000,000 H. P. Annually If Conserved. Wherefore I Have Invented My "Electric Knitting Economizer" Here Shown in Detail. The Knitting Needles Are All Attached to a Common Shaft Connected With a Dynamo; the Dynamo Charges a Storage Battery, Which Supplies Electric Light and Heat in Abundance. This Is What I would Call "Hooverizing Hoover." The Coal, Gas and Electric Purveyors Will Now Proceed to Faint. Inventor, John J. Loehle, Jr., Lebanon, Pa.

QUESTION BOX

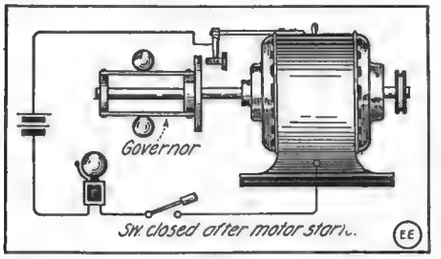
This department is for the sole benefit of all electrical experimenters. Questions will be answered here for the benefit of all, but only matter of sufficient interest will be publisht. Rules under which questions will be answered:

1. **Only three questions can be submitted to be answered.**
2. **Only one side of sheet to be written on; matter must be typewritten or else written in ink, no penciled matter considered.**
3. **Sketches, diagrams, etc., must be on separate sheets. Questions address to this department cannot be answered by mail free of charge.**
4. **If a quick answer is desired by mail, a nominal charge of 25 cents is made for each question. If the questions entail considerable research work or intricate calculations a special rate will be charged. Correspondents will be informed as to the fee before such questions are answered.**

WIRING DIAGRAM.

(881) T. G. Rogers, Nobel, Can., states:

Q. 1. I would like to know if you could suggest something in the shape of an electric bell or light signal to give warning that a belt had broke, or that a motor had stopt on an acid pump. Motor drives the pump by belt, and the idea is to notify a person in a building 60 feet away that the pump has stopt. A bell would be the most suitable, or a red light to light up would do.



A Simple, Positive Alarm for Use on a Motor Driving An Acid Pump. As Soon as the Pump Stops the Bell Rings.

A. 1. We give herewith one suggestion from which you can obtain pointers on the building of such a device.

This scheme utilizes a small governor secured to the motor shaft which operates thru a lever as indicated. A contact which is closed operates the electric bell thru the electrical circuit as shown. Another method by which you can obtain the same results is to introduce in the motor circuit an automatic circuit breaker which, when the motor will stop, trips the circuit breaker, and then automatically closes the external bell circuit for signal purposes.

ELECTROLYTIC FURNACE.

(882) O. R. Dixon, Portland, Ore., says:

Q. 1. I very much desire to get data on an electrolytic furnace and thought perhaps you would be able to tell me where I can obtain such information either in book form or otherwise.

A. 1. We regret to say that the information which you ask in reference to the Electrolytic Furnace cannot be had as this data is still in the hands of the inventors, and is not disclosed for public use at the present time.

TELEPHONE ACROSS THE OCEAN.

(883) F. Brown, Jacksonville, Fla., asks:

Q. 1. Why cannot speech be transmitted by cable across the ocean?

A. 1. The reason why it is not possible at the present time to communicate telephonically across the ocean is due to the fact that high capacity in the cables distort tremendously the wave shape of the telephonic waves, which naturally destroys the effects of speech, and thus it does not permit true speech to be carried on thru such a line.

Another reason that prohibits such a project is due to the inherent high resistance of such cables which reduces the electrical current necessary to operate the receiving equipment, and as you perhaps may know, the current used in telephonic work is very minute. Thus any obstacles tending to destroy their intensity would naturally destroy the intensity of speech. However, the former reason is the greater obstacle which prevents the use of these cables for telephoning across the ocean.

LOOSE COUPLER.

(884) Geo. M. Phillips, Washington, D. C., asks:

ODD PHOTOS WANTED AT $1.00 EACH ! ! !

Now is the time to make your Kodak pay for itself in a real practical way. We are after interesting photographs of out-of-the-ordinary electrical, radio and scientific subjects and are willing to pay $1.00 *cash for every one we can use. Please bear in mind that for half-tone reproduction in a magazine, a photograph should be particularly sharp and clear. Of course, if a subject happens to interest us particularly well, we can have the photo retouched. For the general run of subjects, however, it does not pay to go to such expense. Therefore, please take pains to properly focus and expose your pictures. It often happens that a really mediocre subject well photographed wins approval over an excellent subject poorly photographed. And don't send us plate or film "negatives"; send unmounted or mounted "prints," perferably a light and a dark one.*

As to what to photograph: Well, that's hard for us to say. We leave that up to you, and every reader now has the opportunity to become a reporter of the latest things in the realm of Electricity, Radio and Science. But, please remember—it's the "odd, novel or practical stunts" that we are interested in. Every photo submitted should be accompanied by a brief description of 100 *to* 150 *words. Give the "facts"—don't worry about the style. We'll attend to that. Enclose stamps if photos are to be returned and place a piece of cardboard in the envelope with them to prevent mutilation. Look around your town and see what you can find that's interesting.*

Address photos to—Editor "Odd Photos," ELECTRICAL EXPERIMENTER, *233 Fulton Street, New York City.*

Q. 1. I am making a loose coupler and want to know if the secondary is wound opposite to the direction of the primary.

A. 1. We would inform you that the direction of winding of the secondary with respect to that of the primary must both be in the same direction, as this tends to mutually couple these two coils with a minimum loss due to counter-electromotive forces which may be set up due to opposite windings.

MOTOR DESIGN.

(885) W. F. S. Jr., Corregidor, Philippine Islands, would like to know:

Q. 1. Kindly explain the general principles governing the design of small fan motors which will operate on either A.C. or D.C. of 110 volts?

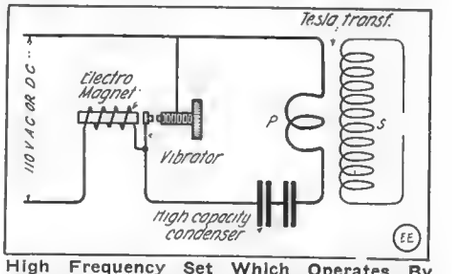
A. 1. There are several factors which control the design of a small motor, and the following must first be known before the procedure of design for such a motor is undertaken, *viz.*, the physical size of the machine, that is, over-all dimensions, and the power which the machine is to deliver (in this case about 1/32 of a horse power would be sufficient.) Another point which must be considered is the general shape of the magnet field; for good practise the bipolar circular field is advisable. The size of the magnet field-poles may be either circular or square in form, but the former is preferable as it gives better winding facilities than the latter type. The shape of the pole-pieces is controlled by the diameter of the machine. Also, the field winding is controlled by the depth of the winding space. The resistance of such a field when employing a series type of motor is very low, while a high resistance field is employed in shunt machines.

This, of course, is controlled by the external conditions of the machine. For the class of machine which you mention, the series type is preferable, as in this case both alternating and direct currents can be used for operating it. The armature magnetic circuit depends upon the internal diameter, and the magnetic field in which this armature is to be rotated. The armature should be made of a number of laminated soft iron discs; the number of slots on the armature is dependent upon several factors which we cannot discuss in detail here. However, for the size of motor in question, a six-slot armature would suffice. The number of field poles for this machine would depend entirely upon the speed of the machine, and upon the magnetic flux density of the magnetic circuit. The commutator should contain six sections.

HIGH FREQUENCY SET.

(886) John Ives, Chicago, Ill., writes:

Q. 1. Is it possible to obtain high frequency current from a buzzer in order to operate an Oudin or Tesla transformer? If it is possible to operate one, kindly give wiring diagram.



High Frequency Set Which Operates By Means of a Buzzer, Shunted by a High Capacity Condenser, on 110 Volt A. C. or D. C. Circuits.

(*Continued on page* 711)

Turning 8c Cotton Into $4.50 Silk

World-Famous Chemist Has Stolen Secrets of the Silkworm—Mechanical Silkworm Now Takes Poor Grades of Cotton and Turns It Into Lustrous Silk—An Invention That Should Revolutionize the World's Silk Industry.

By A. A. ALVORD

Contributing Editor Farmer's Fireside Bulletin, Official Organ of the Texas Farmers' Union.

Mr. Alvord's article, part of which has appeared in the Farmer's Fireside Bulletin, the Official Organ of the Texas agriculturists, reveals a wonderful new industry which has been added to the many industrial enterprises of Texas. This invention has been investigated by Prof. J. B. Bagley, head of the department of Textile Engineering of the Agricultural and Mechanical College of Texas, who has reported the invention to be absolutely practical and feasible. The story of Frederick Wide's process, which turns the cheapest grades of cotton, as well as the better grades, into fine silk worth $4.50 a pound is of paramount interest, as silk is a world-wide necessity the supply of which has been greatly curtailed by the European war.

I have seen with my own eyes a modern miracle of science.

I confess freely that had anyone told me beforehand what I was going to see I should probably have been so convinced that what was claimed could not be done that I might not have witnessed this marvelous demonstration of the wonders science can produce. But I went and I CAN NOT DOUBT THE EVIDENCE OF MY OWN EYES. Even now I am a good deal like the farmer at the circus who gazed on the long-necked giraffe intently for half an hour, then scratching his head, turned away, saying: "Shucks, there ain't no such animile."

Incidentally my brain is still dizzy from trying to calculate the simply unbelievable profits that this invention is bound to make. When my brain had soared into millions—more millions than I care to enumerate—I realized that the wealth-creating possibilities of this modern miracle of science meant fortunes for scores.

In a nutshell here is what I saw:

I saw refuse cotton, what is known in the cotton trade as "Linters," worth ordinarily from SEVEN TO EIGHT CENTS A POUND turned into exquisite, lustrous, shimmering silk worth at present quotations $4.50 A POUND AS YARN for textile or thread making.

Before I go any further let me tell you something about silk.

WORLD FACES SHORTAGE OF SILK

Silk is to-day of practically universal use. There is hardly a man, woman or child in the United States that doesn't use silk in some form. It is used for hosiery, for dresses, for underwear, for linings, for trimmings, for ribbons, for all kinds of draperies as well as for hundreds of commercial purposes in industries of various kinds.

MR. FREDERICK WIDE

Mr. Wide has invented and perfected a process for manufacturing silk from cotton. By this process cotton worth 8 cents a pound is turned into silk for which there is a ready sale at $4.50 or more per pound. Read the wonderful story of this great invention.

A great part of the world's supply of silk is produced by Italy and France. The war has practically stopped this production. The great plains of Northern Italy which have recently been devastated by the Teuton armies produced countless tons of the beautiful product. We must now look to Japan for our silks, and so vividly does Japan realize the importance of its silk industry that to carry silk worms out of the country is punished most severely by the Japanese authorities.

In the last few years a silk substitute has been manufactured in Germany, Belgium and England. This has been enormously successful and has made fortunes. But Germany, Belgium and England have turned their artificial silk factories into gun cotton plants and practically none comes from there any more. So the problem of producing silk enough to meet the world's demands is a vital one.

This wonderful invention is a great stride towards the solution of this big problem.

A MECHANICAL SILK WORM

Back of most of the great utilitarian inventions of to-day is the mighty brain of some chemist.

Back of the new silk is the genius of a great chemist.

Frederick Wide. Write this name on your memory tablets, and write it deep, for it is the name you will hear much of in the future, as he is the man who has found a way to turn eight-cent cotton into silk worth $4.50 a pound.

If you could talk to Mr. Wide, and if you had a sufficient knowledge of the science of chemistry necessary to understand what he told you, he could show you, step by step, how science learned from the silk worm the secrets of silk making.

He could tell you how scientists studied the silk worm, its habits, its methods, its foods, the processes of evolving the secretions which it spins into those gossamer filaments, so slender yet so strong and so wonderfully lustrous.

He could tell you how those secretions were analyzed until they had no more secrets to conceal.

He could tell you why those secretions flowing from the cocoon hardened on contact with the air, becoming so wondrously strong and lovely.

He would tell you all these things in language overloaded with words and names, verbs and adjectives you had never heard before and probably would never hear gain. He would tell you how science

PROF. J. B. BAGLEY.

Prof. Bagley is a graduate of Wake Forrest College, N. C., and one of the foremost cotton mill experts of the world. He was with the North Carolina Cotton Mills '01-'02; North Carolina Textile '01, '04; Instructor in Texas Textile School, '05-'07; Instructor in Mississippi Textile School, '07-'08; Professor of Textile Engineering, Texas Agricultural and Mechanical College since 1908.

studied the chemical reactions which occur in the stomach of the silk worm and change its food of mulberry leaves into the juices that become silk.

Then he would tell you how science, working from known facts, devised a purely mechanical means of doing that which the silk worm has been doing without knowing why, since the beginning of time. He would tell you of the mechanical silk worm which is revolutionizing the silk industry.

MAKING SILK OUT OF COTTON

Perhaps Mr. Wide would tell you that the chemical components of silk and cotton and wood are practically the same, just as he could tell you that science is bending its efforts to turn many substances of which we have quantities into other articles of which we need quantities. He could tell you how chemists have taken the refuse of the gas plants—known as coal tar—and made from it wonderful dyes, exquisite perfumes, powerful medicines. He could tell you how the waste of scores of industries has been turned into fortunes. And then he could explain to you why the same component elements in different combinations make wood, and sugar and cotton and silk and other substances.

Then he could tell you of the experiments covering years of effort that had as their object the discovery of the processes by which silk is formed in the body of the silk worm and how to obtain the right combination of elements into a genuine silk, real as the silk of the silk worm, with all its wonderful lustre and strength and qualities. He could tell you that years ago the chemists had succeeded in making silk out of cotton, but that they had made a silk that was as inflammable and explosive as gun cotton, which in fact it was. And then he could tell you how experiments by the thousands were made before the secret of making a silk from cotton that was neither explosive nor inflammable was obtained. It would take a book many times larger than this magazine to tell that story in full. So to keep this article in the brief confines of a magazine story we will let you guess at all those transitions and come down to the secret of turning cheap cotton into expensive silk. It is a story worth telling. I will try and tell it to you simply, just as it impressed my non-technical mind.

DISSOLVING COTTON LIKE SUGAR

Any kind of cotton can be used in making silk. The cheaper grade—what is known as "linters" and "short staple"—is used for two reasons: because it is cheaper and just as good, and because it is practically a waste product, while the long-staple cotton is useful and necessary to humanity. The true scientific chemist is ever a utilitarian, seeking to use that which seems useless.

This cotton "linters" comes generally from the cotton seed mills, being a by-product of the seed, from which it is removed by mechanical processes before the seed is milled into oil. This short-staple cotton is a dirty yellowish color and carries more or less impurities. It is therefore submitted first of all to a thorough cleansing process and then is bleached white as driven snow. When these first processes are completed the cotton is in a soft, fluffy mass. It is like the absorbent cotton used by physicians and it is ready for processing into silk.

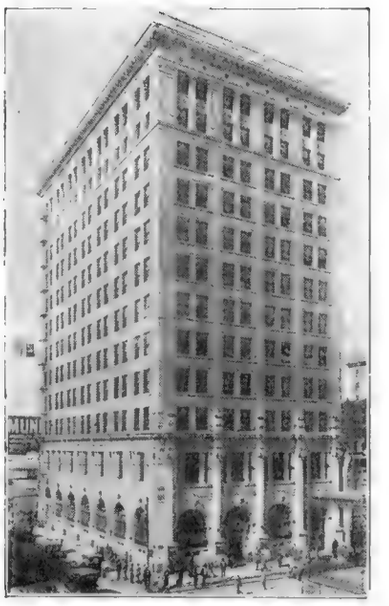
Incidentally you may be interested to know that Mr. Wide is planning to manufacture thousands of pounds of cotton for medical purposes as well as silk.

This cotton is then plunged into glass or porcelain-lined vats which contain a solution which is the secret of the process. This solution contains many chemical ingredients. In these vats take place the chemical actions which turn the cotton into silk, just as the contents of the stomach of the little silk worm turn the mulberry leaves into silk.

THE MECHANICAL SILK WORM

As soon as the cotton is completely immersed in the solution it melts just like a lump of sugar plunged into water will melt. Then a curious thing happens. The whole mass turns a beautiful blue, clear and sparkling as an Italian sky. When the correct proportion of cotton has been added to the solution to properly impregnate it, then the contents of the vat, which are now thick like syrup, are poured into a machine. This machine is the mechanical silk worm.

If you have ever been through a factory where silk is manufactured from the silk worm you will have seen bundles of cocoons, each cocoon yielding a tenuous thread like the diaphanous web woven by a spider. These many threads are gathered to one reel by the deft fingers of girls, who keep it ever twisting and turning into a soft, golden-colored yarn.



UNION NATIONAL BANK BUILDING.

This is one of the fine office buildings of Houston, Texas. It is the home of the Houston Bank & Trust Company, of which Mr. Ben N. Garrett is president. The executive offices of the Texas Textile Company are also located in this building.

The mechanical silk worm has hundreds of tiny glass tubes, each ending in a point pierced with a microscopically small perforation. The bright blue, syrupy cotton solution is forced out through these myriad minute tubes, flowing out in a fairy web so fine that each thread is hardly visible, yet when gathered together these threads make a soft, bright blue yarn, as silky as any silk spun by mulberry-fed silk worms. Practically the only difference is that instead of being golden yellow, like natural silk, this artificial silk is bright blue. The silk is gathered on spools that wind the soft filaments into a glossy yarn. This web hardens on contact with the air.

There is still one more process before the yarn is ready for shipment to the textile manufacturers to be made into all kinds of varieties of silk goods. This is the bleaching process. The bright blue yarn is given another bath, this time in a bleaching agent, and it comes out white as the purest mountain snowdrifts.

WONDERFUL ECONOMY OF PROCESS

The most wonderful part of this whole process is that in none of the operations is there any waste.

A pound of the cleansed cotton yields a pound of silk and even the ingredients of the solution that effects the magic change in the character of the cotton are recovered from the bleaching bath to be used over and over again.

This man-made silk has all the characteristics of natural silk. It is strong,

MR. BEN N. GARRETT.

Mr. Garrett is the successful Texas banker who has associated himself with Mr. Wide in the Texas Textile Company, which has been organized to develop Mr. Wide's great invention. He is the head of two other great corporations which have been most successful.

MR. C. A. LEWIS.

Mr. Lewis is cashier of one of Houston's largest banks and a member of the Board of Directors of two large Texas Corporations. He was formerly with the Security National Bank of Dallas, Texas He is a man who has risen to the front ranks in the Banking Fraternity.

and durable like silk. It takes any dye like real silk. It is as white and remains as white as natural silk. It is non-inflammable like real silk. It has all the sheen, lustre, softness and radiance of natural silk. It wears like real silk and holds its glossiness like real silk. It can be laundered over and over again without losing its color, or the lustrous beauty of the fabric or the softness of texture. IT IS SILK, a man-made silk, another triumph of human brains and ingenuity, of scientific skill and industry.

The chemical change that occurs in the stomach of the silkworm that turns the fibrous mulberry leaves into silk is practically the same chemical change that turns the cotton of our great cotton fields into this silk.

Do you wonder that I read FORTUNE in those filaments of bright blue as they shredded from the mechanical silkworm?

Do you wonder how big that fortune may be when I tell you that this eight-cent cotton is turned into silk worth $4.50 a pound?

That was the recent price, but this price is going up all the time owing to the shortage of silk from Italy, France, Japan and China! What it may go to no one can tell. Shortage of supply of any article of great demand always results in higher prices. Natural silk is worth over $7 a pound right now, I am told; $4.50 is the price for the manufactured article such as Germany and Belgium and England had been sending us. Experts who have examined the imported manufactured silks and the silk made by the Wide process say the Wide silk is a big improvement on the old world product.

WAR HAS HELPED DEVELOP INDUSTRIES

The war has been a big thing for American industry in many ways besides making fortunes in war brides, as they playfully call the ammunition and arms companies that have made phenomenal fortunes in providing the fighting nations with arms, ammunition, etc.

Before the war we bought our natural and manufactured silks abroad. Before the war we bought all our dyes from Germany. Before the war we bought all our lenses and watch crystals from Germany. Before the war we bought all our potash fertilizers from Germany. Hundreds of chemicals, acids, fabrics, manufactured metals, pigments, machines, textiles, etc., came to us from abroad. War closed the ocean lanes to the importation of these goods and American inventiveness and enterprise, forced to exert themselves, have remedied the shortage by duplicating these necessaries of life and in many cases we have improved on the originals.

Mr. Wide is an Englishman. He has been one of the biggest men of the man-made silk industry in England. He was one of the pioneer chemists in this field working hand and glove with the chemists of Belgium and Germany who were striving to produce an artificial silk to meet the world's demand for this product. When war was declared he was at the head of one of the biggest artificial silk manufacturing companies in England. With the coming of war the factory was turned into a munition plant. With his plant closed, as far as the manufacturing of silk, Mr. Wide decided to come to America. He knew the world needed absorbent cotton for treating wounds and for dressings. He came here to make his knowledge and experience valuable. Probably the first work the new factory will do will be to turn out great quantities of absorbent cotton, which will be one of the important by-products of the Texas Textile Company, as will be explained further along.

He had Texas in view as the place of opportunity. Texas, the wonderful Lone Star State, which produces one-fourth of all the cotton produced in the world and which offers greater investment opportunities than any other state in the Union.

GENIUS AND POWER JOIN HANDS

What more natural, once he had cast his far-seeing eyes on Texas, than that he should gravitate towards that organizing and developing genius of Texas, Ben N. Garrett, the young giant of industry with the touch of Midas. In Texas they liken this young genius of finance to the god of ancient mythology, whose touch turned things to gold. In Houston they will tell you that everything Ben Garrett touches turns to gold, that he has made a record of success in financing propositions that has been the amazement of the financial world.

So the genius of science and the genius of finance met on common ground and from the union of these two geniuses has been born an enterprise that promises to add tremendously to the industrial importance of Texas and that should earn fortunes for the lucky ones who "string along" with Ben Garrett.

When Mr. Wide and Mr. Garrett met neither knew very much about the other and each tells now, laughingly, what elaborate precautions each took to find out about the other.

Garrett's first thought was to find out how much of the wonderful story he had heard from the lips of Wide was to be credited. Wide set about finding out whether Garrett was the right man to tie up to. For a few days they sparred around in New York, each making excuses to the other to avoid coming to a decision. Garrett corroborated Wide's statements by cablegrams from American consular officers in England and from other reliable sources of information in London. When both had arrived at the conclusion that the other was the right man to tie up to further details were soon settled.

FAMOUS COTTON EXPERT CONSULTED

Among the men Mr. Garrett consulted was Professor J. B. Bagley, head of the department of Textile Engineering at the Texas Agricultural and Mechanical College. Prof. Bagley is probably the greatest cotton expert in the country, if not in the world. Prof. Bagley's report was not only satisfactory, it was enthusiastic. He was so enthusiastic that his first thought was to invest in the company which Mr. Garrett was planning to organize. He has since become a large stockholder and is Vice-President of the company, but that is going ahead of my story.

Mr. Wide accompanied Mr. Garrett back to Texas and immediately set about establishing his laboratory, which he had brought with him from England. This laboratory contains a complete equipment,

on a small scale, for turning cotton into silk.

Once the laboratory was set up, Mr. Wide invited Mr. Garrett, Prof. Bagley, the writer and a few other associates of Mr. Garrett to a demonstration of the process.

I have already described to you how he took the cotton and plunged it into the vat of solution, how he poured the syrupy melted cotton into the mechanical silkworm and how the filaments of the pure bright blue silk were pressed out of the needle-like points of the capillary tubes, hardening as they struck the air into web-like threads of lovely silk.

The demonstration was so convincing that it was practically decided at that time to go ahead with the proposition. Mr. Garrett, however, whose successes have been won by combining a splendid daring with a wonderful caution and almost superhuman sense of opportunism, wanted to be absolutely sure before he went ahead.

Here was an industry that meant much to the state if it was successful, he argued. Hence, he told himself, it was essential to get the public attitude towards such a proposition. So he compiled a report of all that he had seen, all that he had learned of the process, its possibilities, the market for the product and the costs of production, the raw material, everything, in fact, that could throw any light on the proposition, and made this up into a circular, which he submitted to the leading bank directors of the state of Texas. He wanted a consensus of opinion. HE GOT IT. From all parts of the state came most favorable reports. "Texas wants your silk plant," is what they told him, and many of these big banking men, the most solid and responsible element in the state, volunteered to subscribe for stock in the company once it was formed.

Satisfied now that he was right, Mr. Garrett went ahead and organized the TEXAS TEXTILE COMPANY.

The TEXAS TEXTILE COMPANY is organized in a similar manner to many of the largest concerns in the United States, such as the Magnolia Petroleum Co., the Long-Bell Lumber Co., the Pierce-Fordyce Oil Association, etc. The articles creating this organization vest control of its affairs in a board of trustees, pledge the assets of the organization for its liabilities, and exempt the stockholders and trustees from personal liability for same. This is a powerful safeguard of the interests of all stockholders. No bonds of any kind have been issued and there is no preferred stock. All stock is common stock, fully paid up and non-assessable. Every shareholder in the business will hold exactly the same kind of stock and participate in the profits in exactly the same ratio as every other stockholder. This, Mr. Garrett believes, is the fairest and safest type of organization for all interested.

COTTON READY FOR SHIPMENT.

One-third of the world's total production of cotton is shipped through the Houston gateway to foreign countries. This is a typical scene at a cotton wharf where the huge 500-pound bales of cotton are assembled ready for shipment on steamers to foreign ports. This cotton, ranging in price from 8 to 20 cents a pound, can all be converted into silk worth $4.50 a pound, or more, by the Wide processes.

He personally advanced all the necessary funds for organization work. He personally bought and paid for, in the name of the company, the rights to Mr. Wide's process, and he also bought Mr. Wide's laboratory equipment, his supplies, machinery, etc., advancing the necessary funds for all expenses.

COMPANY SECURES FACTORY SITE

It was decided to locate the factory in the outskirts of Houston on the Houston ship channel, that great inland waterway which leads from the heart of this beautiful city to the Gulf of Mexico and which is navigable by the big ocean ships.

The factory site was bought. It has 300 feet of frontage on the ship channel with its own docking facilities, a great advantage, as water routes are always the cheapest for shipping goods.

Jno. W. Maxey, one of the great efficiency engineering experts of the South, was engaged to plan the factory in conjunction with Mr. Wide, so as to make it as efficiently perfect as possible. The first of these buildings is now in course of construction. It is of brick and concrete, absolutely fireproof. Mr. Wide was immediately sent to Philadelphia to get together his machinery. Part of this is standard equipment which is used in all cotton mills for cleansing and bleaching the cotton. The rest is now being built under Mr. Wide's own supervision from his own plans.

So efficient and methodical has been the work of development of the company's plans that in less than ninety days from this publication the factory should be in operation, turning the cotton of Texas into silk fit to grace an imperial queen. They say up North that we of the South are slow. The New South—especially the South of Texas, is anything but slow. This achievement proves it.

COMPANY IS MODESTLY CAPITALIZED

When I asked Mr. Garrett particulars about the capitalization of the company he smiled. "The Texas Textile Company is only capitalized for $250,000," he said. "You may be surprised at this modest capitalization, but we do not need a great deal of money to put this proposition on its feet and the smaller the capitalization the bigger the dividends. The stock is all common stock, fully paid up, full profit-sharing and non-assessable."

I asked him what the company was going to earn. Again he smiled. "Dividends are pretty hard things to predict," he said, "but let us consider a few facts. We have planned a factory that will start with a machinery equipment capable of handling from 600 to 1,000 pounds of cotton a day; 600 pounds a day would mean 600 pounds of silk produced a day. This has a value of $4.50 a pound in its yarn form. The cotton should not cost over 10 cents a pound, perhaps 6 to 8 cents. Even by allowing a very liberal margin for expense, overhead, labor, selling costs, etc., the total expense of producing a pound of silk, including the cost of the cotton, should not possibly exceed $1. That leaves us a profit of more than $3.50 a pound of cotton handled. If you figure what 600 pounds a day at $3.50 a pound profit means you will get a fair estimate of what our earnings ought to be. As a matter of fact, we expect to be handling 1,000 pounds of cotton a day very soon after we get started. Then as we get into the swing of the thing and profits begin to accumulate, we plan to enlarge our capacity to 2,000, 5,000, 10,000 pounds a day. The additional investment will not be large and the greater the production the lower the overhead costs so, as we increase our production, we should also increase our profits proportionately. 10,000 pounds a day, even at a profit of only $3.50 a pound would make a very nice income. Don't you think so?"

PROFITS FROM BY-PRODUCTS

I certainly agreed with him. Then he added:

"In addition to producing silk we shall have several by-products that ought to increase our earnings quite substantially. We shall probably start right out making absorbent cotton. There is a great need for it in the army hospitals. In fact, the government and the Red Cross are urging all cotton manufacturers to give them all they can turn out. Cotton batting is another by-product that we can manufacture with our equipment. Medicated cotton is another. Gun cotton base is another in great demand by powder works. Another good by-product will be artificial horsehair cloth for the tailoring trade which we shall be able to make in a very superior quality, much better than the real horsehair cloth the tailors and dressmakers use now because we can spin a thread like horsehair a mile long if necessary, so that there will be no raw hairs sticking out of the fabric, as is the case with the short horsehairs they have to use now. There are other by-products which the market will give us an opportunity to make and which will add to our profits. So you see our little company should be a very nice income-maker."

STRONG MEN DIRECT THE COMPANY

No matter how great the opportunities of an enterprise may be it is, after all, the HUMAN ELEMENT that makes or unmakes success. The genius of men like John D. Rockefeller, J. Pierpont Morgan, Andrew Carnegie, E. H. Gary, Henry Ford, Westinghouse, Vail, Marshall Field, has been the deciding factor in creating the success of the enterprises their brain, energy and enterprise has created.

The TEXAS TEXTILE COMPANY is managed by men of KNOWN SKILL and ability whose success INSURES the success of this company.

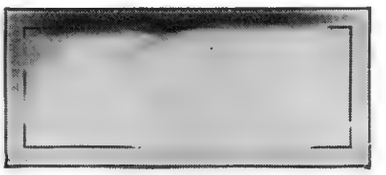
BEN GARRETT, President of the company, is one of Houston's prosperous financial men. He is the executive head of two corporations with a combined capital of $600,000, and during the past year these two companies have disbursed to their stockholders $360,000 in cash dividends and disbursements, with over $100,000 yet on hand to be distributed this year. Just think of it! $360,000 in dividends in one year for companies with a capitalization of only $600,000. Isn't that PROOF of the financial genius of this man?

Prof. J. B. BAGLEY, Vice-President, is, as I have already told you, head of the department of Textile Engineering of the Texas Agricultural and Mechanical College, a position he has held for the past twelve years. The company is particularly fortunate in securing this eminent expert as an officer. His valuable knowledge and wide experience will be of inestimable value to the company.

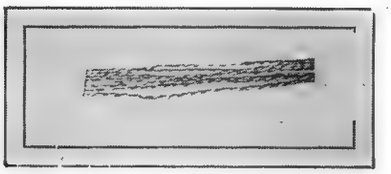
FREDERICK WIDE, Managing Director, was for many years superintendent of textile factories in Belgium, Holland and France. He was superintendent in charge of the Thos. A. Edison and Swan Company, manufacturers of phonographs and electrical equipment at Cologne, Germany. For the six years prior to his coming to the United States Mr. Wide was in charge of a large silk factory in England and considered one of the foremost chemists and manufacturing experts in Great Britain.

C. A. LEWIS, Secretary and Treasurer, was formerly connected with the Security National Bank of Dallas, Texas, and an active director of two large Texas corporations. He is now cashier of one of the largest private banking institutions in the Southwest.

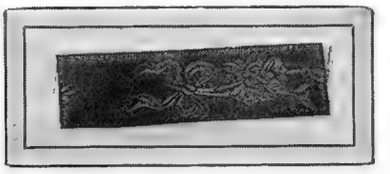
HOW COTTON IS MADE INTO SILK



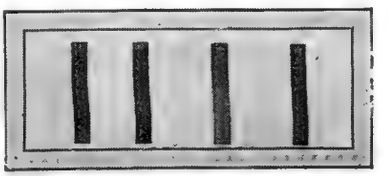
This is the raw cotton after being cleaned and bleached ready for making into silk.



This is the same cotton turned into silk yarn by the Wide process and with the Wide machine, which has been called the Mechanical Silkworm. This is the way it looks before bleaching.



The Wide silk woven into rich silk fabrics. It has all the sheen and lustre of natural silk and will take any dye.



Another sample of silk made from the yarn manufactured by the Wide process. It takes the most delicate dyes and can be laundered over and over again without losing its sheen or color.

With such men at its head the TEXAS TEXTILE COMPANY is well officered indeed and its prospects are more than promising.

POSSIBILITIES OF THE COMPANY

The possibilities of the company are so large that even a cursory examination reveals opportunities of dazzling dimensions. It is a well-known fact that the world's greatest entomologists and silk worm experts have exhausted all known means of increasing natural silk production. The demand for silk is growing greater every day. We live in a luxurious age. The world demands silk and MUST HAVE IT. There is no way to escape the fact. The war has not only curtailed the production of silk, but it is quite probable that irremediable losses in silk worms have been sustained in the invaded Italian plains where this industry thrived.

Mr. Wide has given us a process of manufacturing silk in unheard of quantities from a staple article of very low price. SCIENCE HAS MET THE CALL OF DEMAND.

With the artificial silk factories of Europe closed down we have practically a MONOPOLY OF THE PRODUCTION.

The supply of raw material of this cheap grade is practically inexhaustible. There are known to be from 3,000,000 to 4,000,000 bales of low grade cotton produced EVERY YEAR. Each bale weighs 500 pounds; 4,000,000 bales means TWO BILLION POUNDS of low grade cotton which can be converted into silk, and that's EVERY YEAR.

We have now over 100,000,000 people in the United States and all of them, from the babe in its cradle to the ancient tottering to the grave, use silk in some form or other.

That's only in THIS COUNTRY, but the WHOLE WORLD is clamoring for silk.

IS THERE A MARKET FOR THIS PRODUCT?

The question is futile. If we didn't know anything about silk at all we could easily guess the answer. But we do know. We know also that the present price—now about $4.50 a pound for textile silk—is apt to grow much higher very soon as the pinch of shortage is felt more keenly. Indeed, it has increased in the last month from $3.85 to $4.50 a pound.

Houston, Texas, is the ideal location for the factory. It is the gateway of the Southwest. Through this gateway are shipped annually to foreign ports ONE-THIRD OF THE WORLD'S PRODUCTION OF COTTON. Houston is the radiating center of a network of railroads and waterways that traverse the entire Southwestern section. Within ten miles of the TEXAS TEXTILE COMPANY'S factory is one of the greatest oil producing districts in the country, the famous Goose Creek field. That means VERY CHEAP FUEL for power.

Labor is cheaper and more abundant in Texas today than anywhere else in the country. Living is cheaper here. Freight rates are cheaper owing to the competition of rail and water routes.

Why shouldn't this company set records in earnings to make the biggest dividend payers in the history of industry seem puerile?

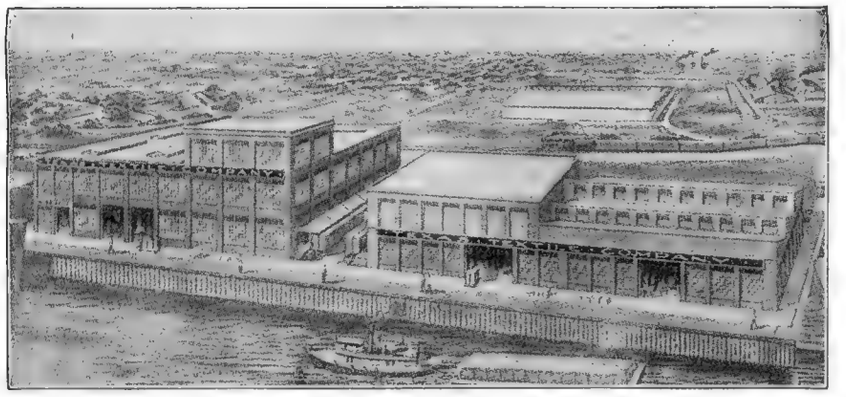
WHY YOU ARE OFFERED THIS STOCK

The natural question that must arise in your mind is: "Why, if this proposition is so good, do Mr. Garrett and the Texas Textile Company invite subscriptions from me and other investors? Why not take it all to the bankers who recommend it so strongly? Why doesn't Mr. Garrett keep it all himself?

The question is a natural one. It is a question every man asks who is offerred a specially favorable opportunity to invest. But did you ever stop to think that even rich men have their money invested, often where they can't easily realize on it? Did you ever stop to think that the Eastman Kodak Co., which has earned enormous dividends, has over 1,600 stockholders; that the Goodrich Tire Co., another phenomenal earner, has nearly 4,000 stockholders; that the Pennsylvania Railroad has over 90,000 stockholders; the National Biscuit Co. over 7,000 stockholders, and so on?

Mr. Garrett had faith in the company enough to advance to it thousands of dollars before he even had a contract with Mr. Wide for his process. His banker friends had enough faith in Mr. Garrett to back him with thousands more that have been spent in bringing the company to its present development when a few more weeks will see it housed and equipped ready to start manufacturing.

Then, another thing, you should know Mr. Garrett, as his friends know him, to understand why he wants other people interested in the company. Mr. Garrett has been the financial guardian angel of hundreds of investors for whom he has made money. He is not a philanthropist,



FACTORY OF TEXAS TEXTILE CO.

This factory is now in course of erection. It is located on the Houston Ship Channel, which connects Houston with the Gulf of Mexico, and which is navigable to the big ocean freighters. The factory is being rushed and all machinery and equipment are now on the way. The factory should be running inside of 90 days.

but he likes to make money for his clients because he wants their aid in financing propositions. He knows that the only way to build up a strong list of investing clients who will "string along with him," as the saying goes, is to make money for them. If he can put YOU in the way of making money the next time he needs financial support to back some new enterprise you will be ready to go in with him, won't you? Yes, of course. I'll tell you the story of one of his clients that I happen to know about. The man's name is Kavanaugh, Claude Kavanaugh. A year ago last Summer Mr. Garrett advised him to invest in an enterprise financed by the Garrett interests. Mr. Kavanaugh couldn't realize on his own resources immediately so he borrowed $3,590.00 which he invested with Mr. Garrett. This investment has paid Mr. Kavanaugh, as he told me himself, $34,428.00 in cash dividends in a little over a year and the market value of the investment is, according to Mr. Kavanaugh, approximately $51,000.00. A total return of over $85,000.00 in ONE YEAR'S TIME, and all from an investment of only $3,590.00.

FORTUNES FROM SMALL INVESTMENTS

It was Jay Gould who said: "A hundred dollars invested in the right place at the right time, will earn as much as one man steadily employed." And Andrew Carnegie, who is said to have founded his fortune running into hundreds of millions by investing $250 of borrowed money in an invention that made him a little fortune, said once that the biggest difference between a good business man and a poor one is that the good business man goes ahead and does a thing while the other is thinking about it. These are two wonderful business precepts that every man should bear in mind.

Little investments grow into big fortunes just like little acorns grow into stately trees. BUT YOU MUST MAKE THE INVESTMENT. The acorn in the bin won't grow into a tree any more than the uninvested money will grow into a fortune. Just to give you an idea of how little money acorns grow into big profit trees:

George Westinghouse is said to have offered a half interest in his airbrake for $2,500. Westinghouse Airbrake earned $6,500,000.00 in the fiscal year ending July 31, 1917.

James Couzens is said to have borrowed $100 from his sister to invest it in Henry Ford's "dream company," as they called it a few years ago. That $100 has drawn in CASH over $47,000.00 and the hundred dollars' worth of stock is now worth over $50,000.00.

The Postum Cereal Co. started 16 years ago with $750.00. Three years ago, 13 years after it was founded, the company's assets were $20,000,000.00 and Post left an estate of $22,000,000.00.

If you had invested $100 in the original capital of the Gillette Safety Razor Co. your stock would now be worth $52,000.00 and your annual income from it would be $3,640.00. All from an original investment of $100. Here is a little list compiled from Moody's Manual showing briefly what $100 invested in some well-known companies would be worth today:

$100 invested in Bell Telephone has returned	$ 54,000.00
$100 invested in Cream of Wheat now represents	10,000.00
$100 invested in Prestolite has returned	100,000.00
$100 invested in Burroughs Adding Machine has returned	41,340.00
$100 invested in National Cash Register has returned	42,870.00
$100 in Welsbach Mantles has returned	50,000.00

And this list could be continued for pages showing how small investments in the right thing at the right time have grown into fortunes.

The TEXAS TEXTILE COMPANY is capitalized for only $250,000, divided into 2,500 shares of the par value of $100 each, full paid, non-assessable and full profit-sharing. These shares are now offered at $110 per share.

If you take President Garrett's estimate of possible earnings and profits you find that 600 pounds a day at a profit of $3.50 a pound means a profit, over and above all probable costs, of $630,000.00 a year, or over 250% profits on the total capitalization of the company. Here you see the great advantage of a small capitalization. If the company had been incorporated for $1,000,000.00 this would represent a profit of 63% instead of nearly over 250%.

These profit possibilities are not offered as a definite statement of anticipated profits, because no one can predict the future nor foretell the events of life. They are merely estimated from known, definite factors. If the production should reach 1,000 pounds a day—as it is predicted it soon will—the profits would be, at this basis of estimating, $3,500.00 daily and on a basis of 300 working days a year $1,050,000.00 a year, or over 400% on the total capitalization. By setting aside a portion of the profits for surplus and for factory development it would soon be possible to increase the capacity of the factory to 10,000 pounds a day which at the old basis of estimating earnings would mean profits of $10,500,000.00 a year, or 4,000% on the capitalization.

NEVER SUCH AN OPPORTUNITY

Even a casual study will reveal that this is one opportunity such as very few men have ever had offered them. Knowing the demand there is for silk and the enormous shortage, no one interested in the company believes that it will stop at even a production of 10,000 pounds a day. Its ultimate production may run into many times ten thousand pounds a day. Who shall estimate what the profits would be once the company has reached such a development? It doesn't take a prophet or a man of very wide vision to see what this stock will be worth some day. That's why I said at the beginning of this article that the profit possibilities were so big that they were dizzying. I got into such big figures that my brain was swimming in millions. And the strange part of it is that, exaggerated as these figures may seem, they are probably TOO CONSERVATIVE.

Can you think of any other opportunity to invest money with enormous chances of success equal to these? The European silk companies have made enormous profits. The English company's profits increased from $174,375.00 in 1908 to $2,371,000.00 in 1913. This company had much experimental work to do at first and it wasn't until the later years that its product was perfected and its methods of manufacturing improved to modern efficiency. This company made these enormous profits in spite of paying two or three times as much for raw material as the Texas company has to pay and having to export its product or sell it at much lower prices than now prevail. These figures are believed to be official, as they are taken from authoritative English publications.

We do things on a much bigger scale in America. We leap ahead where others crawl. The growth the English company worked up to in six years this company will probably span in one-third the time.

If you have an ounce of vision, if you are not one of the short-sighted men who can never see beyond the ends of their noses, if you have a speck of imagination, if you have a spark of daring you'll invest all you can afford to in this company. Mr. Garrett has provided for carrying the stock of those who cannot afford to pay in full for their stock. A reservation payment will hold the stock you want. You can pay down $12 on every share you want and pay the balance $14 a month until you have paid the full price of $110 a share. This offer will not be repeated. This stock should advance rapidly. In 90 days the factory should be in operation and the stock should begin earning dividends. It may be earning dividends before you have finished paying for it.

With only a limited number of shares available it is likely that this allotment will all be subscribed for in a few days. It is necessary therefore not to delay. ACT QUICKLY by filling out the coupon below and mailing NOW with your reservation remittance of $12 for each share you want. Then you can pay the balance at the rate of $14 a share per month for seven months.

But unless you expect to be disappointed ACT NOW.

You may never have such another opportunity. It is the ONE opportunity of a lifetime and no man or woman can afford to ignore it. Here you have an absolute necessity, a tremendous profit margin, a wonderful market, strong, clean, honest, business men behind the company, complete and efficient management, an almost unlimited supply of raw material, cheapness and economy of manufacturing costs. If you have a few hundred or a few thousand dollars to invest you might wait all your life and not get such another chance to put your money where it has such splendid opportunities for turning a small investment into a good sized fortune.

You will have to hurry. The capitalization of the company is small, a great deal of the stock has already been subscribed for, the plans of the company are progressing so fast that soon this stock will advance in price very materially. The remaining shares should be snapped up in a few days.

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Name .....

Address .....

Postoffice ..... State.....

QUESTION BOX.

(*Continued from page 704*)

A. 1. It is certainly possible to operate a Tesla transformer with a buzzer providing that the vibrator of the buzzer is sufficiently large and is capable of being run on 110 volts either D.C. or A.C.

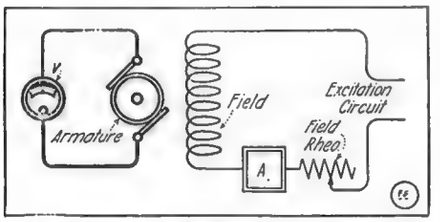
The diagram here gives the proper connections. The oscillatory condenser must be of high capacity or in the neighborhood of .01 mfd.

DYNAMO QUERY.

(887) John Russell, Omaha, Nebraska, wishes to know:

Q. 1. Kindly advise me how to connect a shunt-wound dynamo, so that the field magnetization can be tested.

A. 1. We give wiring diagram herewith.



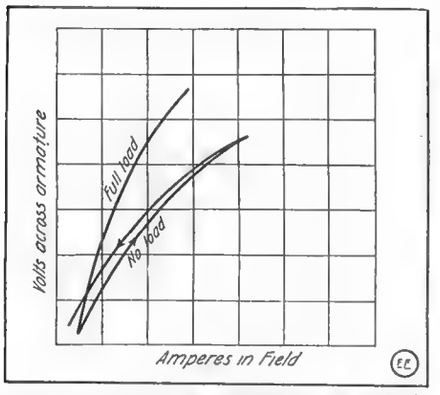
Connection of Shunt-wound Dynamo for Testing Field Magnetization.

Q. 2. What general type of curves does the field magnetization follow?

A. 2. The typical curves obtained from such a test are herewith given.

Q. 3. Upon what does the percentage of saturation in the field depend.

A. 3. This factor depends upon the rate of graph curvature increase that the current and voltage take, and it is a ratio between a small amount of field excitation and that of a small amount of electromotive force produced in the armature circuit. This ratio gives the percentage of magnetic saturation in the field.



Curves of Field Magnetization for Shunt-wound Dynamo.

FORM FACTOR

(888) John Henley, Detroit, Mich., wishes to know:

Q. 1. How is it possible to determine the average and effective values of an alternating current which is not a sine wave?

A. 1. The problem of determining the average and effective values of an alternating current circuit of non-sine wave form is difficult, as several factors must be considered before such determination

(*Continued on page 712*)

BOOK REVIEW

THE PRINCIPLES OF ELECTRIC WAVE TELEGRAPHY AND TELEPHONY, By J. A. Fleming; 911 pages with numerous illustrations; size, 6 x 9"; Publisht by Longmans, Green & Co., New York and London. Third Edition. Price, $10.00.

This excellent and large volume might readily be called the "Bible" of Radio-telegraphy. An untold wealth of information and data is covered in nearly a thousand pages, and represents a book that will find its value constantly by the ready reference it gives on all matter pertaining to Radio, both practical and theoretical.

This third edition has been thoroly revised and rearranged and some new and interesting chapters have been added. The author's aim has been to deal more fully with principles than to give elaborate accounts of actual apparatus, altho much standard equipment is shown and described.

The work is really a comprehensive view of the entire subject of Radio from its scientific side, and much space has been devoted to quantitative measurements, their theory and how to make such measurements.

The following outline gives some idea of the many phases and subjects covered:

High Frequency Electric Currents, Damped and Undamped. Electric Oscillations, Graphic Representations of Undamped and Damped Electric Oscillations, Mathematical Expressions for same, High Frequency Alternators, including those of Thomson, Tesla, Fessenden, Goldschmidt and others; Theory of the Discharge of a Condenser, Mathematical Expressions for Dead Beat Oscillation Discharges, Objective Representation of Electric Oscillation with numerous notes, theories and experiments in this direction; Induction Coils and Methods of Winding with numerous types of interrupters and breaks; Condenser Construction, both Leyden jars and glass-plate condensers, comprest air, oil immersed and other forms; Oscillation Transformers, arrangement of apparatus, various forms of discharges; Disc-ball and Air blast for cooling; also exhaustive data on the arc transmitter and the quenched gap.

Further subjects cover High Frequency Electric Measurements, Theoretical and Practical Measurements for Resistance, Induction, Capacities, etc., and all others connected with Radio circuits, Strengths of Various Dielectrics, Measurement of Spark Frequency and Spark Counting, Damping, Resonance, Logarithmic Decrement, Damping, and their application to all forms of Radio Circuits.

Then we find chapters on Aerials, Radiation, Detection and Measurement of Electric Waves, Commercial Radio Apparatus, Early Ideas and Experiments, and various phases of the art are covered from the simple apparatus to the most modern apparatus.

Further sections treat on Practical Radio-telegraphic Stations, Commercial, Experimental, Transatlantic, Government and the Types of Apparatus employed in each, with a discourse on Undamped Wave and Arc systems.

The final chapter covers all important experiments and the practical applications of "Radio-telephony," and should prove of great interest.

The work has a number of interesting photos of Spark discharges and Oscillatory discharges of a Condenser.

The book is of such large proportion and the data so varied that it is almost impossible to discuss in detail the remarkable fund of information contained therein. Suffice it to say that its value will prove itself daily in the constant and ready reference it will give to radio students and engineers alike and to all those interested in the radio art.

PRACTICAL WIRELESS TELEGRAPHY, By Elmer E. Bucher. Fully Illustrated; 322 pages, size 6¼ x 9½"; cloth bound. Publisht by Wireless Press, Inc., New York, 1917. Price, $1.50.

An excellent work is this latest book on Radio and it should find a host of readers, especially those who intend taking assignments in the Signal or Flying Corps and the Navy.

The book is written in a practical manner, covering the various fields of commercial as well as advanced radio, giving the student an opportunity to acquaint himself with standard practise.

The author has treated all subjects without rigid scientific accuracy or completeness, but nevertheless in such a manner as to enable one to grasp the fundamental electrical and magnetic principles, and consequently when these simple laws are learned the rest comes in easy stages, step by step, so that the student gets the why and wherefore of things.

By no means must it be interred that this book is an elementary work for data of great interest to the advanced and professional man is contained therein.

(*Continued on page 713*)

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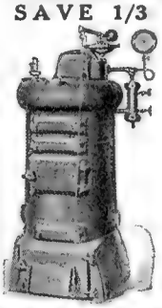

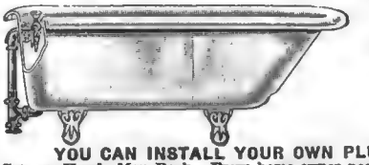

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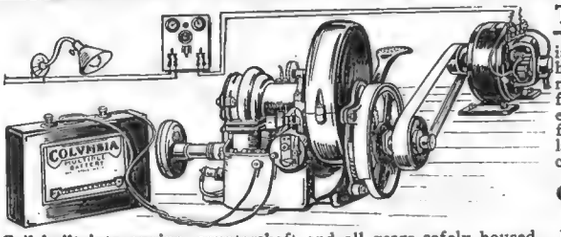

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QUESTION BOX.

(*Continued from page* 711)

can be made, *viz.*, the shape of the curve must first be obtained, either by pure oscillografic means or by obtaining the various values of current or voltages at various times, and plotting a curve. This curve should extend between two limits, that is, between the starting of the current and that of ending, or between starting and the maximum. In other words, expressing this relation mathematically, the current must pass thru π radians, or in other words, thru 180 electrical degrees. The area inside this curve must be measured either by a planimeter or by carefully erecting small squares of known lengths and determining the area of these individual squares, and multiplying the area of them by the total number of squares inscribed inside of the curve.

This would give an approximate area of the curve. Having obtained this area, the next thing is to carefully measure the length of the datum or base line of this curve, and divide this value into the area. The quotient of this will give the average current value. The effective value is obtained by squaring the ordinates and abscissae as originally obtained, and plotting a new curve with these values. The area of this new curve is determined the same as the first, and dividing this area by the new base, and the square root is subtracted of this quotient which will give the effective value of the curve, which may either be current or volts.

Q. 2. What is the form factor?

A. 2. The form factor is the ratio between the average current and that of the effective current, and is exprest in the following relation:

$$\text{Form factor} = \frac{\text{Effective E.M.F}}{\text{Average E.M.F}}$$

HIGH FREQUENCY ALTERNATOR.

(889) J. Pignone, Bronx, N. Y., asks:

Q. 1. Kindly state thru the "Question Box" how many volts and amperes the best selenium cells can withstand.

A. 1. The voltage necessary for operating a selenium cell is variable, as the general physical properties which is dependent upon the construction of the cell, control generally the voltage necessary to operate this device at its maximum efficiency. There are no definite rules from which one can determine theoretically the voltage necessary to operate satisfactorily any selenium cell. It must be found experimentally.

Q. 2. What size wire and how much should be used in coils A and B in my diagram of a high frequency alternator, capable of exciting an arc for a wireless telephone?

A. 2. The winding for the excitation currents of an alternator which you show in your illustration should consist of 250 feet of No. 26 B & S magnet wire. This amount should be wound on each of the coils between the receiving current coils. These latter coils are wound with 10 to 12 feet of No. 20 wire. This small amount is used in order to diminish the skin resistance when operating at high frequencies. However, the flux density produced by the former coils must be very large so as to obtain the maximum E.M.F. when the device is in operation.

VARIOMETER QUESTION.

(890) Fred Stanford, of Louisville, Ill., wishes to know:

Q. 1. Will you kindly inform me as to the construction of a variometer?

A. 1. There are several means by which you can construct a variometer. One of the simplest involves the use of two con-

centric tubes, each of which is wound with the same size wire. The winding of one tube should be opposite to the other.

A good variometer can be made by obtaining two cardboard tubes, one of which is 5 inches in diameter, while the other is 5½ inches. The width of both tubes should not exceed one inch. A single layer of No. 20 insulated magnet wire is wound on both tubes, and the winding is properly shellacked. Both tubes are electrically interconnected, while the terminals are obtained from the inner and outer coils. The inner coil is permitted to revolve 180 geometrical degrees, and this is obtained by means of a rod protruding thru the coils, to which a handle is attached for properly rotating the inner tube. On page 685 of this issue you will find a complete treatise on the operation of this instrument.

SELENIUM CELL QUERY.

(891) W. M. Van Dusen, of Akron, O., wishes to know:

Q. 1. What is the formula for designing selenium cells; also what size wire should be used for different voltages.

A. 1 There is no formula at the present time for the design of selenium cells to perform certain operations, as the subject is still in its infancy, and the data is still in the hands of the scientists. We can refer you, however, to the September, 1917, issue of THE ELECTRICAL EXPERIMENTER.

VACUUM PUMP.

(892) E. S. Rogers, of Toronto, Can., inquires:

Q. 1. Could the laboratory vacuum pump described by R. F. Yates in the November issue, be used to create a high enough vacuum for an Audion bulb?

A. 1. The vacuum pump as described by Raymond Francis Yates in the November issue of THE ELECTRICAL EXPERIMENTER, can be successfully utilized for the exhaustion of Audion bulbs, providing that the exhaustion is continued for a considerable period. This is due to the fact that a column of mercury in a glass tube is of insufficient size to exhaust the air within the tube completely. You can of course construct a special pump, so that you can evacuate the air chamber within the tube in one operation. This can be done by increasing the dia. of mercury column.

Q. 2. Where can I obtain information regarding the amount of vacuum in the Audion?

A. 2. We refer you to the September, 1915, issue of the Proceedings of the Institute of Radio Engineers in which you will find an article by Doctor Irving Langmuir which treates extensively on the subject of relative values of vacuum in tubes of this type.

Q. 3. Why is it that when a permanent magnet is moved around near the Audion, signals can be tuned in and out by its different positions. I don't understand the phenomena taking place in the tube.

A. 3. The reason why a permanent magnet will tune and dētune the radio signals is that the electronic discharge of the cathode or hot filament is directed and redirected from the course which it takes to the wing circuit, and by changing the *concentration* of the electronic stream to this plate you are changing the flow of a current which is taking place betwen the hot cathode filament and the anode plate—thereby causing a variation in the strength of signals.

Actually, you are not tuning or dētuning the signals by resonance means, but purely by changing the conductance within the Audion, thus changing the strength of current thru the audio-telephone circuit.

(*Continued on page 714*)

BOOK REVIEW

(*Continued from page 711*)

Among the various chapters may be noted excellent discourses on Magnetic Circuits, Electromotive Force and Induction, Motor Generators, Storage Batteries, Transmitters, Receivers, Circuits, Auxiliary Apparatus, Radio Measurements, Standard Sets, Direction Finders, also Transmitters and Receivers of Undamped Oscillations. The various Armstrong vacuum valve circuits for producing "beats" in the reception of undamped waves are illustrated and described in a very creditable manner, as well as an explanation of the principal radio-frequency alternators.

The appendix contains various formulas, and a complete set of questions such as might be asked of those taking examinations for licenses.

TRENCH WARFARE, by J. S. Smith; cloth bound; 6½ x 4¼"; pocket size; 144 pages; 17 illustrations. Price $2.00. Publisht by E. P. Dutton & Co., New York, N. Y., 1917.

The author of this interesting little book is an American, serving with the British Expeditionary forces as Second Lieutenant. Mr. Smith having enlisted early in the war has had much opportunity of studying modern trench warfare in the British trenches in Flanders and Northern France.

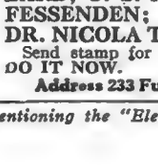
While the volume contains not a very great abundance of new matter, the author has endeavored to condense into a small volume quite a good deal of valuable information that will be welcomed by our officers and privates alike. There are many interesting chapters, such as: Dugouts, Latrines, "Sand Bags," Support Points, Communication Trenches, Obstacles and Entanglements, Explosives, etc. The chapters treating on Listening Posts, Sketch of Trench System and Bombs, are perhaps the best. The illustrations are clear and leave nothing to be desired. The book can be warmly recommended to all students of trench warfare. The only thing we find fault with is the peculiar dry style in which the author writes.

THE WIZARD OF THE ISLAND, by F. G. Winger. Cloth bound; 160 pages; 7¾ x 5½"; 3 illustrations. Price 50 cents. Publisht by Winger Publishing Co., Chicago, Ill., 1917.

The author who terms his book a "Pseudo-Scientific Novel," has produced an interesting addition to our rapidly growing scientific fiction. The story treats on the "Vindication of Prof. Waldinger" living in the year 2015, who having been misunderstood by his fellow scientists retreats to a wonderful island where he succeeds in actually demonstrating the truth of his former wild-appearing theories. Several of his scientific opponents are subsequently wrecked on the Wizard's island, due to the latter's mysterious machinations and now the wizard begins to lead them a merry scientific dance. Prof. Waldinger introduces us to his "Vibrometer" by means of which we are made to "see sound," "hear colors" and witness other startling—as yet to be invented—phenomena. While this chapter, supposedly the most important one, is very interesting, the author has neglected to show in a plausible manner just how these various means are produced.

Most of it is too vague and kept too general, not in keeping with the style of first-class scientific stories—as for instance those of Jules Verne—where all, as yet unknown phenomena or effects are always explained in a plausible manner. The other chapters of the book do not lack this essential as for instance the "steam mountain"—a novel idea, by the way—which sounds quite plausible.

The story is well written and keeps your interest till the end. The only fault we find are the illustrations which are rather amateurish. If you are interested in a good scientific story, read the "Wizard of the Island." You will like it.



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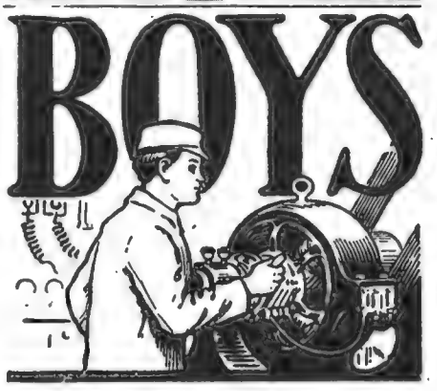

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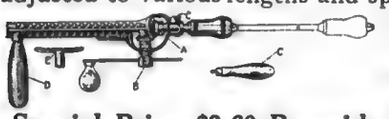

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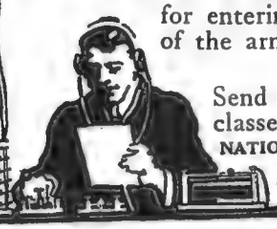

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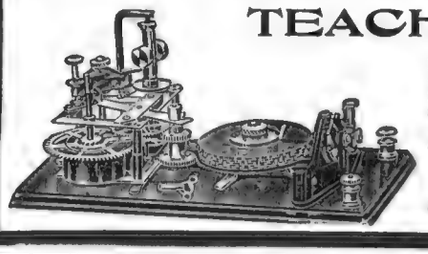

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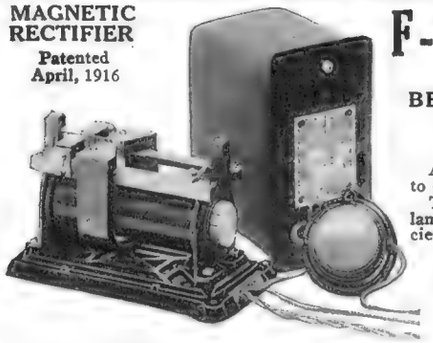

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ELECTRICAL CONDUCTION IN METALS AT LOW TEMPERATURES.

(*Continued from page* 693)

one-eighth, respectively, of those for the same wire when straight. No attempt has yet been made to measure the gradual further increase of resistance which would be expected on this theory as the current is further increased and more and more turns become resisting.

The following table contains in condensed form the observed values of threshold current for various wires at different temperatures as published by the Leiden Laboratory. Since the threshold values depend considerably on temperature, a comparison is possible only when observations were made on two wires at the same temperature, and the table contains the results of practically all such observations published.

In the last column is given the maximum value of magnetic field in any part of the conductor—that is, the field at the surface of a straight wire or at the inner turns of a coil (the computations for the latter case being only approximate)—due to its own threshold current. It is seen from the table that at each temperature this magnetic field is much more nearly a constant of the material than either the current or current density. In the case of mercury the effect of a magnetic field on the resistance in the superconducting state has not been measured. For tin the threshold value at 2° K. is about 200 gausses, which is in good agreement with the slightly larger values computed from the threshold current corresponding to a slightly lower temperature. In the case of lead the agreement of the observed critical field (600 gausses at 4° K.) with the computed values is not so good, particularly in the case of the straight wire. Any discrepancy here, however, is easily explained by the possibility (frequently referred to by Onnes) of the existence of thin spots in the wire where the field intensity would be much greater for a short length.

Critical Values of Current for Various Metals and Temperatures

[From data by H. K. Onnes]

Temperature degrees K	Area	Threshold current	Threshold-current density	Maximum magnetic field
	mm²	amp.	amp./mm²	gausses
MERCURY				
4.1	0.0016	0.17	107	15
	.0025	.17	69	12
	.0055	.23	42	11
	.0055	.32	58	15
3.6	.0016	1.00	625	89
	.0025	1.07	427	76
	.004	>1.04	>260	>59
	.0052	.78	151	39
TIN. Hcrit. =200 at 2° K				
1.6	.0143	1.0	70	*a*430
	.0143	8.0	560	*b*240
LEAD. Hcrit. =600 at 4°.2 K				
4.25	.025	9	680	*b*385
	.014	>4	>300	*c*>110
	.014	.6	41	*a*375
1.7	.014	.84	60	*a*550
	.014	11.1	790	*b*330

a Coil. *b* Straight wire. *c* In vacuo.

Further experiments which immediately suggest themselves are measurements on the critical magnetic field for mercury. The relation here advanced would indicate a critical field of only about 15 gausses at 4°.1K and less than 100 gausses at 3°.6 K. It would also be of interest to observe the threshold value of current when the material is in very thin films. In this case for a given section of material the magnetic field resulting from a given current density is less than in the case of a straight wire, and the threshold-current density would consequently appear larger.

The theories thus far proposed to account for superconductivity by Onnes, Lindemann,

and Thomson do not specifically indicate the existence of a critical magnetic field, and only the latter accounts for a threshold-current density (by assuming a saturation effect). If it is true, as indicated in this paper, that the magnetic effect is the more fundamental, it would seem that this fact might afford a valuable clue leading toward a more satisfactory theory of the superconducting state and perhaps of metallic conduction in general.

EXPERIMENTAL PHYSICS.

(*Continued from page* 680)

EXPERIMENT 58—

The making of enlargements is practically as simple as the taking of the photograph, but altho this phase of the art is very interesting, it is not indulged in much by amateur photographers because of the mistaken notion of its difficulty. All that is necessary is an ordinary camera (better the camera that took the negative to be enlarged) a window admitting sunlight, a few pieces of wood and cloth and some tools. The back of the camera should be taken out and the camera attached to the window (with the back at the window) the negative inserted between the window and the back of the camera and the rest of the window boarded up. By the use of some cloth the room may be made light tight so that the only light entering the room will come thru the negative, thence thru the lens and into the room. The sun's rays will now illuminate the negative (this illumination can be intensified by placing a piece of white cardboard outside, meeting the window at an angle of about 45 degrees, thus reflecting the rays against the negative). Now the negative has become the object to be photographed and its image can be caught on the wall of the room, or better, on an upright piece of white cardboard or easel. If the lens is in position A (Fig. 51), the image of the negative will be formed at I, and by slight movement may be focused sharply. The size of the enlargements is EF. If the lense is moved to position B, the image is at II, and its size is denoted by CD. Thus we see that the further from the back we move the lens the smaller the picture. If bromid paper is placed in the position where the enlarged image was sharply focused and an exposure of the right length (determined by trial or from handbooks) is made and the paper developed, the enlargement will be finished. If one wishes to enlarge by artificial light a light-proof box may be constructed with the artificial light in it, and the camera fitted to it in the same manner as if it was attached to the window. The rest of the operations will be identical. The process of reduction (the inverse of enlarging) is exactly the same except that the lens is moved out from the back of the camera very far, the image becoming smaller than the negative. (See Fig. 51.) The essential details in regard to the formation of the image having been given we shall now close the article by considering a few of the principles of color.

White is a combination of several colors, and can be broken up into its constituents, while black is simply the absence of color. As in the case of sound we shall fix our attention not on the physiological sensation of light and color but on the physical considerations.

EXPERIMENT 59—

If ordinary sunlight is allowed to pass thru a prism (see Fig. 52) the sunlight (white light) will be broken up or "dis-

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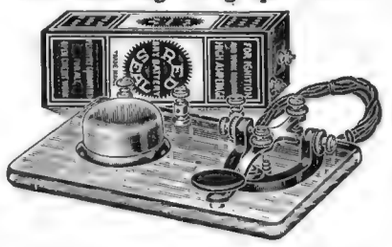

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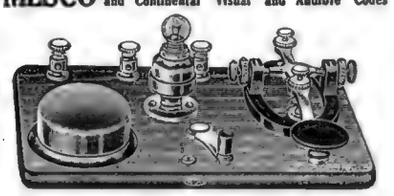

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persed" and a sort of rainbow will result. Note that the violet is bent (refracted) most and the red least but *all are bent* to some extent. Since light is a wave motion and the violet waves are the shortest and the red the longest, just as in the case of water waves, the short ones on meeting an obstruction are retarded more and, therefore, bent more. The rainbow is the same phenomenon caused by the sun's rays meeting the drops of water.

EXPERIMENT 60—

If white light is allowed to pass thru two prisms (see Fig. 53-A) the result is white light since the light bent up by the first prism is bent down by the second one, etc. This is equivalent to a piece of glass with parallel sides (see Fig. 53-B). The placing of the two prisms together is analogous to the placing of crown and flint together to secure a lens free from chromatic abberation.

The color of opaque bodies under white light is determined by their relative powers of absorbing and reflecting the different colors. For example, a body that absorbs all colors except red, reflects the red and we say its color is red. If it reflects more than one color the resulting color of the body is the combination of those reflected.

The color of transparent bodies viewed by the light passing thru them depends upon the light they permit to pass thru. If a body transmits all colors equally its color is white. If it transmits only one color, say red, its color is red, but if it transmits several colors its color will be that which results from combining the transmitted colors in the relative amounts in which they are transmitted.

Complementary colors are two colors which when added together give white, as, for example, yellow and ultramarine blue are purple, and green or violet and yellowish green.

(*To be continued.*)

HOW NEW YORK POLICE USE RADIO.

(*Continued from page* 682)

Marine Division of the Department—the Division which gives the same protection to New York's six hundred miles of waterways, that the rest of the force gives the land part of the city. With the outbreak of the war, altho practically all the other privately owned wireless plants were closed, these three stations were continued in operation, under supervision of the Navy Department, and new work in conjunction with the several Government wireless stations covering the Metropolitan District. Nearly nine hundred important radiograms connected with the work of the police force have been exchanged between the "Patrol" and the headquarters stations, which could not have been handled in any other manner. The promptness with which orders and reports can be exchanged with the "Patrol" is, therefore, of valuable assistance to both the Federal and the Municipal Government.

The "Patrol" is stationed at Pier A, at the lower end of Manhattan Island, and cases where police aid is needed on the surrounding waters are reported immediately to Headquarters or the Pier A precinct by telephone. When the boat is at the dock it is sent to investigate, and when circumstances require it, the commander of the boat sends a wireless report of the matter investigated to the headquarters wireless operator for delivery by telephone. When the "Patrol" is cruising around the bay, such messages are sent by the headquarters wireless operator direct to the boat. Previous to the installation of wireless, when the boat was cruising, it was necessary to tie up at some dock, and for an officer to find a telephone, in order to communicate with headquarters or the Precinct. This took considerable time, particularly at night. Now communication is instantaneous, which increases the efficiency of the Harbor Police considerably.

A few of the many cases where the wireless has enabled prompt police service to be rendered are mentioned below. In each instance altho the "Patrol" was away from the pier, communication with it was establisht instantly, whereas valuable time would have been lost in notifying the crew of these occurrences, under the old system.

May 18th, 4:00 A. M.—Two barges broke away from the pier at the foot of East 54th street, and, driven by a strong wind and tide, swept up the East River and carried three more away from the pier of East 70th street. The five then drifted out thru Hell Gate, in the path of the fleet of steamers that come in thru Long Island Sound early every morning. The "Patrol" was off Staten Island when this information reached headquarters, and was notified by wireless about four o'clock. At 5:35 A. M. it reported by wireless that four of the barges had been caught and docked by the police boat, and that the fifth was taken in charge by a tug.

May 21st, 1:00 A. M.—A small fire occurred in the Metropolitan Hospital on Blackwell's Island. The "Patrol," cruising around the lower bay was notified by wireless, and to stop at the East 51st Street pier for a Battalion Fire Chief on the way. When the fire was out, wireless orders were given the boat to continue cruising.

May 26th, 3:00 P. M.—Richmond Telegraph Bureau notified Harbor A of a fire on board a Municipal ferry boat bound from New York to Staten Island. The information was wirelessed to the "Patrol" which was in the East River, and promptly investigated. At 3:39 P. M. it reported by wireless that the fire was extinguished with slight damage.

June 5th, 4:35 P. M.—Brooklyn Telegraph Bureau was notified by a citizen that people in a motor boat off Manhattan Beach were waving distress signals. The Brooklyn wireless operator sent the message to the "Patrol' which was cruising up the East River, but immediately started to the rescue. At 5:16 P. M., the commander of the boat inquired by wireless if any further information had been received and the Brooklyn operator, after communicating with the citizen who reported the matter sent the following message to the boat at 5:28 P. M.—"Party in motor boat off Manhattan Beach still waving white flag. Coney Island Life Corps tried to reach them and failed." The "Patrol" reached the location at 6:15 P. M., just as the disabled launch was taken in tow by a fishing steamer.

July 13th, 1:50 P. M.—Trouble on a steamship anchored in the harbor was reported by telephone to Harbor A. The "Patrol" was sent to investigate and it was found that a member of the crew of the steamship had been dangerously stabbed by another sailor during a brawl. A wireless hurry call for an ambulance to meet the "Patrol" at the pier was sent to Manhattan headquarters at 2:10 P. M., and the injured man was brought ashore, and placed in the waiting ambulance at 2:10 P. M., and taken to the hospital, where he subsequently recovered. His assailant was arrested and held.

August 26th, 6:50 P. M.—It was reported to headquarters by telephone that three barges of coal had broken away from the pier at the foot of East Tenth street and were drifting up the East River. The "Patrol" was sent after them, and reported

by wireless at 9:50 P. M., that all three had been returned to the pier they broke away from, without damage.

The "Patrol" has also met at Jersey City and brought to New York, each of the seven Foreign Commissions that have visited this country on official war business, during the summer, and the wireless equipment of the department on these occasions has been a valuable means of keeping the city officials in close touch with the movements of the parties. If the special train bringing the Commission reached Jersey City at a time other than expected, headquarters was immediately notified by a wireless message from the boat, which was waiting at the Jersey City railroad pier, and the information telephoned to the officials who were interested. When the party boarded the boat a wireless message to Headquarters was telephoned to the Inspector in charge of the line of parade, so that the route could be cleared in time, but with least interruption to regular traffic. Headquarters was also notified by wireless when the party disembarked and the parade started.

In several inspection trips made around New York harbor on the "Patrol" by the different Commissions, accompanied by one or more of the city officials, the wireless was in almost constant use in handling urgent official communications between the officials and their offices, via Police Headquarters and the telephone system.

An extension of the wireless system to some ten or twelve of the seventeen Inspection Districts of the Department is now planned.

EXPERIMENTAL MECHANICS.

(*Continued from page* 689)

motor is mounted in order to secure strong foundation. Fig. 3 shows the manner in which a piece is being fastened to the lathe between two centers clamped to the face plate of the lathe by means of a *dog*. It also shows the position of the operator. Precaution is always necessary around the moving parts of the lathe. More details as to turning objects in a lathe will be described in a forthcoming chapter.

Fig. 4 shows how the lathe is utilized as a drill press. The lathe is a most useful tool for drilling long or short cylindrical articles. The article to be drilled is secured firmly to the revolving chuck, and the drill is secured to a stationary chuck, the arbor of which is tapered to correspond to the hole in the tail stock spindle. The drill is permitted to advance into the metal by revolving the dead spindle handle, as the photograph shows.

In Fig. 5 is seen a circular saw as used in connection with the lathe. This close-up view shows more clearly some of the important parts of the lathe. A small steel or wrought iron table is provided for supporting the metal to be cut. In a later article the writer will discuss more fully the arrangement with drawings as to the construction of this table in conjunction with the saw arbor, and also various attachments in connection with this saw table, so that the experimenter can obtain the full benefit of this valuable attachment.

In the next lesson the author will give a full description of how to use the lathe in actual work, with full details of the various lathe tools employed.

WHY NOT AERIAL "STEPPING STONES" FROM U. S. TO EUROPE.

(*Continued from page* 663)

something after the following fashion: A given airship having reached a "float," lands on the top deck, is lowered to a second and partially enclosed deck by means of an incline or elevator device, where it would be overhauled by the repair crew if necessary. It would leave this particular float for its continued flight thru an opening for that purpose, which opening could be closed during the night time when harboring a number of airships in the capacity of a "rookery."

At night the "floats" would be marked by a ring of powerful vertical shafts of light as the illustration shows. Moving belts driven by electric motors would stop the alighting aeroplanes quickly and also speed them off when leaving. The former belts would travel in an opposite direction to the alighting planes.

Probably an aeroplane could be so accommodated every eight or ten minutes during eight hours of each day, so that within about one year at least 20,000 aeroplanes would be delivered to the shores of Europe.

These gigantic "floats" would also have to be arranged so as to provide an overnight "rookery" between decks, between intervals of daylight flights.

The shortest feasible route would, of course, have to be figured out by those in a position to know, so that a minimum of these floats would be required.

Probably twenty or even more of these floats might be required to successfully span the Atlantic Ocean, all depending, however, upon the length of the span; and the safe flying distance between floats at 200 miles per float, there being twenty floats, would cover 4,000 miles.

Each of these floats could themselves have a coterie of half a dozen or more aircraft soaring and circling above and about their own float, like eagles on the watch for prey—ever and always safeguarding its own particular float from danger. At night this coterie would also find shelter between decks and resume their duty with the approach of day. Torpedo boat destroyers could also be used.

I have not stopt to figure out what size such floats would be required to be to afford shelter over night for both transient and home craft, but it would necessarily be very large. However, the aircraft could be packed closely together and securely lashed to the deck during such enforced idleness. Possibly a length of 1,000 feet would suffice.

The mobility of the floats being practically nil, the defensive features could be carried on to a very large extent, such as practically draping the hull completely with suitable steel nets.

Such a scheme in successful operation and with each other's co-operation would provide an invulnerable pathway across the Atlantic Ocean, and would be in effect the same as if Uncle Sam thrusted a huge fist to the very borders of Germany and still remained immune from attack.

Secret communication would be facilitated as the wireless messages could be relayed between floats, with a minimum of energy, and a corresponding lack of danger of their being received by the enemy.

The suggestion entails big things, but the need is just as great.

GOVERNMENT TO ERECT RADIO STATION.

The United States Government has leased 250 acres of land at Morrisons, about six miles north of Newport News, Va., for the erection of a radio station, it is said, besides its use as an aviation concentration camp. Options have been taken on several large tracts.

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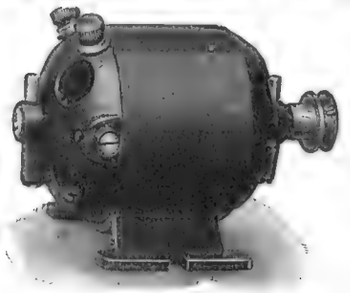

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Excellent for small wood turning, fibre turning, etc.

Lathe is made from finest materials. Size seventeen inches over all—swing 4 inches. 11 inches center to center. Bed is machined and centers accurately; shipping weight is 13 lbs.; price $4.00 cash with order.

Sypher Manufacturing Co., Department C, Toledo, Ohio

THE HOME TREATMENT OF TUBERCULOSIS BY HIGH FREQUENCY CURRENTS.

(*Continued from page* 681)

body—for example, in acute bronchitis or "cold in the chest"—we have as prominent symptoms—fever, congestion, cough and expectoration. Most people think that by taking medicine to suppress these symptoms they can cure the disease; hence the use of cough-syrups, sedatives, etc. When the patient recovers under such treatment it is in *spite of the medicine rather than because of it*, for these symptoms are the very means nature is using to throw off the infection. Extra vital force is being wisely directed to the endangered area—hence the fever, heat, congestion and expectoration. Medical science has been working at the problem of "cure" from the wrong end. Instead of suppressing symptoms we must aid nature to throw off the disease-producing germs and neutralize their poisons. In other words we must assist and promote the process of inflammation. It is because the inflammation is not sufficiently vigorous that many cases of tuberculosis do not recover. The infected areas are usually anaemic to start with and after the infection becomes well establisht the general blood pressure drops and it is still more difficult to establish the healing inflammatory phenomena. Other germs come in and cause secondary infections which greatly hasten the progress of the disease.

Now the D'Arsonval High-frequency current, when applied to certain tissues of the body, produces all the effects of a natural inflammation—they cause "hyperaemia" or increase of blood to the parts, liberate heat and probably promote the circulation of the vital currents. This method is known as "diathermy" or "thermo-penetration" and has been successfully employed in many hospitals and clinics in treating pulmonary tuberculosis. Dr. Albert Geyser, of New York City, reports over *sixty per cent of recoveries* in cases so treated at his Clinic at Fordham University; others have reported equally good results, yet it is a fact that the State Boards of Health, the Public Sanitoriums and thousands of lung specialists ignore this important method of combatting the "Great White Plague."

For those who can make or procure a High-frequency apparatus, such as the writer described in the December, 1917, issue of the ELECTRICAL EXPERIMENTER, or any other standard therapeutic high-frequency apparatus giving both Tesla and D'Arsonval currents, the successful home treatment of tuberculosis is easily possible. The technique is exceedingly simple—once daily for twenty-five minutes, the patient is given a D'Arsonval treatment—a block-tin electrode attached to a cord connected with each terminal of the solenoid being held or strapt in close contact with the skin of the patient's chest and the corresponding portion of the back (Fig. 1), so that the infected area of the lung lies in the path between the electrodes. The spark is opened until the patient feels a deep penetrating heat in the tissues between the tin electrodes. If the heat becomes uncomfortable the spark gap should be made shorter. All physicians' machines are provided with hot-wire milliamperemeters in the patient's circuit. When the meter is available the current strength can be adjusted so as to begin with 1,000 ma.,—gradually increasing this to 2,000 ma., by the second or third week of treatment. A home-made machine operated from a one-quarter K. W. wireless transformer will not give more than 1,200 ma., in Diathermy, but this can be made sufficient by increasing the length of the treatment to forty minutes. Continued daily for months this treatment will bring about recovery in a majority of consumptive patients. It is scarcely necessary to add that proper dietary and hygienic measures should also be employed. Bulletins giving all needed information on these points can be had gratis from any State Board of Health. A physician should be consulted occasionally so that the progress of the case can be intelligently followed.

The use of the "Ozone Nebula" by *inhalation* is of great value in treating tubercular cases and when it is given in connection with Diathermy the chances of the patient's recovery are materially increased. A simple home-made apparatus for this treatment is made from a Welsbach lamp chimney mounted in a wooden upright as shown in the drawing (Fig. 2); one end of the chimney is open, from which the patient inhales the nebula; the other end is closed with a disc of wood thru which is past a short glass tube three-eights inch in diameter; a brass rod ¼" by 8" slides thru a hole in the center of the disc. The inner end of the rod carries a small brass disc 1/16" by 1½"; a small insulating rubber handle being attached to the outer end of the rod. A rubber tube connects the small glass tube with a *DeVilbis Oil Nebulizer* (procurable for a small sum at any large drug store) containing a small amount of "Pinoleum"—a preparation containing oils of pine and eucalyptus.

In treating, the patient sits on the fiber condenser pad which is connected with one terminal of the Tesla coil; the other Tesla terminal is connected to the brass rod in the chimney which is brought up close to the patient's face until a fine purple effluve passes between him and the brass disc. An assistant now alternately compresses and releases the nebulizer bulb, thereby forcing the vaporized oil across the effluve so that it emerges from the open end of the chimney close to the nose and mouth of the patient. The patient, breathing naturally, inhales the chemical combination which is said to form between the oils and the ozone and nitrous vapors formed in the effluve: these are later released in the lung tissues. The action is antiseptic and also carries oxygen into the infected areas. Clinical tests seem to prove that there is a complicated vitalizing effect obtained by the simultaneous use of the ozone nebula and the Tesla currents.

This method was devised some years ago by the writer and differs from all the Ozone and "Oxylene" systems on the market in the above respect; in other words it is a combination treatment of two well recognized healing agents.

It should be given for only a few minutes at a time, and twice daily. If the vapor is too irritating, reduce the effluve by means of the spark gap or by withdrawing the sliding rod in the chimney.

No possible dangerous effects can follow the intelligent use of the electrotherapeutic methods above described, in the home treatment of tuberculosis, and the beneficial results are very marked.

Those interested in using high-frequency currents for the above purpose should obtain the back numbers of the ELECTRICAL EXPERIMENTER containing the articles "Electricity and Life," and "Treatment of Disease by High-frequency Currents" by the writer.

It is hoped that this article may be the means of enabling many sufferers from tuberculosis to regain their health.

After the disease is once cured its recurrence may be prevented by observing the following rules, which are equally appropriate for anyone who wishes to have more abundant health and life.

1. Breathe deeply plenty of fresh air, night and day.

2. Spend a part of each day walking or working out-of-doors.
3. Make at least one meal each day of nothing but fruit.
4. Make the rest of the diet largely or wholly vegetarian.
5. Never "get sorry for yourself"; get busy and help the other fellow who is worse off than you are.

SHOCK-PROOF SCREW-DRIVER FOR ELECTRICIANS.

The insulated shock-proof screw-driver here illustrated is indispensable to employees of Power Plants, Electric Light, Telephone, Railway and Traction Systems, and all others having to do with live circuits.

The long fibre handle serves a two-fold purpose: first, by being made of a firm, insulating material which will not be damaged if dropt from a height to a hard surface; second, by providing ample room for the worker's hands so that they need not come in contact with the blade. This handle will not be impaired if brought in contact with or immersed in Ammonia, Turpentine or Petroleum, it is claimed.

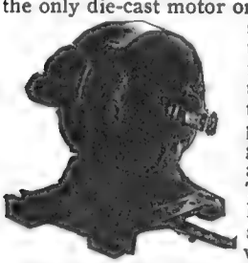
The blade is hammer forged from crucible steel, and its construction inside the handle is such as to constitute firm holding surfaces.

WOMEN AS RAILWAY EMPLOYEES.

The Interborough Rapid Transit Company and the New York Railways, New York, recently announced that as a war measure the companies would receive applications from women for positions as station employees on the subway and elevated lines and as conductors on the surface lines. Preference will be given to dependent women relatives of employees now in the army and navy, and the pay will be the same as for men. It is not the intention of the company to replace men now employed by women, but only to fill vacancies as they occur. Applicants must be between 21 and 45 years of age. The women conductors will be placed on the pay-as-you-enter cars first.

NEW TOY ELECTRIC MOTOR.

A new toy motor has recently been brought out by a Connecticut concern. This motor is wound particularly for battery use but will operate equally as well used with step-down A. C. transformer direct from house current. It has reverse attachment in the base with special features, and the frame is entirely die-cast. It is said to be the only die-cast motor on the market. The motor is exceptionally powerful for its size owing to the accurate fitting of the parts, particularly the air gap between armature and field. The motor is highly finished and should prove a winner with our young Edisons.



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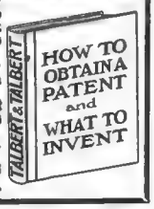

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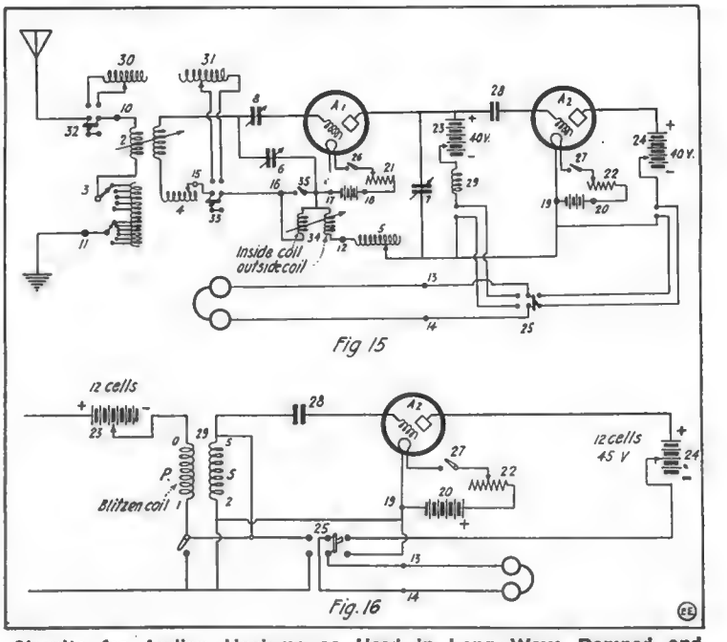
PATENT SPECIALTY COMPANY
462 Sanchez Street San Francisco, Cal.

DETAIL CONSTRUCTION OF A DAMPED AND UNDAMPED WAVE RECEPTOR.

(*Continued from page* 687)

tween the two interacting frequencies. Deducting from this, it is easy to understand that by changing the frequency of the local oscillations by the adjustment of the capacity or inductance at some point in the circuit, the beat frequency or the *tone* of the received signal can easily be varied over a wide range. In this respect the above apparatus is very sensitive. A mere movement of the operator's hand in the vicinity of the circuits alters the capacity of the system sufficiently to cause quite large fluctuations in the tone. Always keep the beat pitch for long wave length stations quite low; otherwise the *compensating wave* radiated will interfere with perfect reception. In receiving long wave length stations with the heterodyne receiver the signals become rough, losing their musical tone qualities, but the intensity is considerably increased.

With the above apparatus the Joly type transmitter at Sayville and the Goldschmidt reflecting alternator at Tuckerton have been heard *over* 65 *feet from the receivers,* using 3,000 ohm Holtzer-Cabot telephones. The German stations have been heard several inches away from the receivers during unfavorable conditions.



Circuits for Audion Hook-up as Used in Long Wave Damped and Undamped Radio Receptor.

CORRECT TELEPHONE HABITS.

The following suggestions are publisht by the New York Telephone Co., at the request of a number of large business houses that are interested in developing pleasing telephone manners among their employees:

On all
OUTGOING *CALLS*

Always look in the telephone book to *make sure* you call the right number. If you do not find the number in the book, ask "Information."

Call *your number* with a slight pause between the hundreds and the tens. For example, in calling "Barclay 1263," say, "Barclay One Two (pause) Six Three."

Speak *clearly* and *distinctly, directly* into the transmitter.

Listen to the operator's repetition of the number and acknowledge it.

Hold *the line* until your party answers and then give your whole attention to the telephone conversation.

To recall the operator, move the receiver hook up and down *slowly.*

When you have finished talking, say "Good-bye" and replace the receiver on the hook.

Remember, courtesy over the telephone is always desirable. It wins friends for you and your company.

On all
INCOMING *CALLS*

Answer your telephone *promptly* and *pleasantly.*

Announce your name and the name of your department. Don't say "Hello."

Be ready with pad and pencil in order not to keep your caller waiting.

If you require help in handling the call properly, get it at once or politely transfer the call to the employee who can best handle it.

If you answer for another employee, offer to take the message, then call it to the other's attention at the first opportunity.

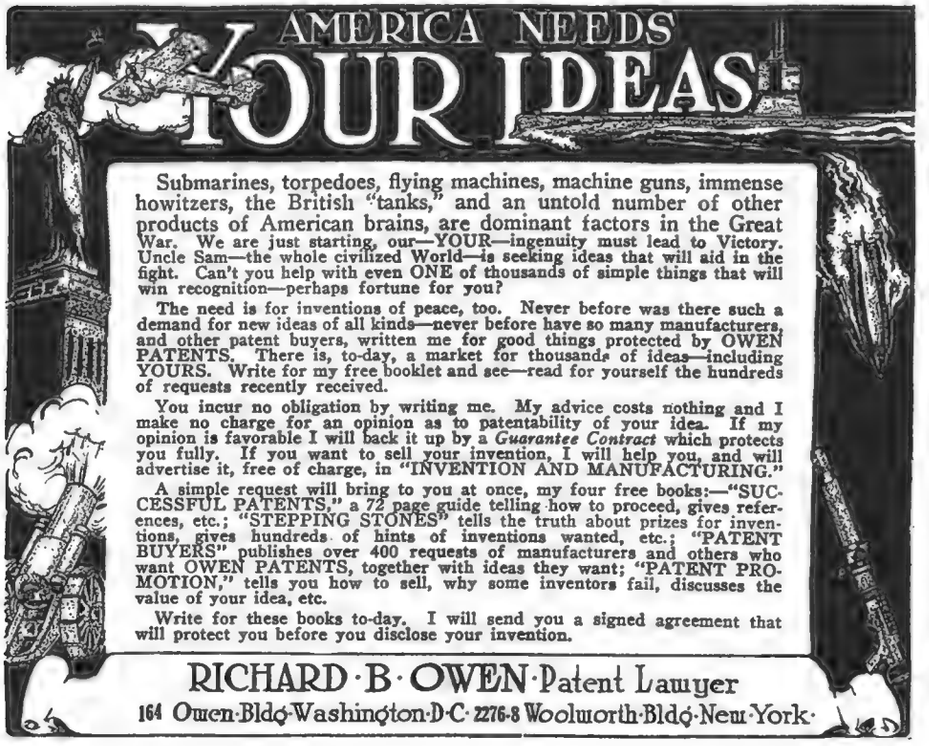
Listen attentively, so that you will not have to annoy the caller by asking him to repeat.

Remember, abruptness or indifference *drives away trade.* Close attention to telephone orders helps win it.

Maintain the same courtesy and consideration in a telephone conversation that you would with your customer face to face.

ENGINE SOOT TIES UP TELEGRAPH LINE.

Trouble that has beset a new line of the Western Union Telegraph Company between Eugene and Marshfield, Ore., since it was constructed and which had been a puzzle to electricians, is believed to have been solved. It has been found that where the wires run thru a 4,300-foot railroad tunnel the insulators have been made conductive by soot from locomotives. Now employes of the telegraph company go over the line within the tunnel and wipe away the soot collections at regular intervals and telegraphic communication is uninterrupted.



Submarines, torpedoes, flying machines, machine guns, immense howitzers, the British "tanks," and an untold number of other products of American brains, are dominant factors in the Great War. We are just starting, our—YOUR—ingenuity must lead to Victory. Uncle Sam—the whole civilized World—is seeking ideas that will aid in the fight. Can't you help with even ONE of thousands of simple things that will win recognition—perhaps fortune for you?

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PATENT ADVICE

Edited by H. GERNSBACK

In this Department we publish such matter as is of interest to inventors and particularly those who are in doubt as to certain Patent Phases. Regular inquiries address to "Patent Advice" cannot be answered by mail free of charge. Such inquiries are publisht here for the benefit of all readers. If the idea is thought to be of importance, we make it a rule not to divulge details, in order to protect the inventor as far as it is possible to do so.

Should advice be desired by mail a nominal charge of $1.00 is made for each question. Sketches and descriptions must be clear and explicit. Only one side of sheet should be written on.

TELESCOPING TELEPHONE SUPPORT.

(197) E. T. Jones, New Orleans, La., has submitted to us a novel idea showing a telephone bracket with a telescoping support, taking up very little room in its normal position. Our advice is asked on the idea.

A. This is a very good stunt and seems to have quite a good many points of superiority over the ordinary telephone brackets, which as a rule take up quite a good deal of room, and do not work easily nor very readily. By making a few minor changes, we think our correspondent may secure a very good patent upon this idea. It certainly looks very simple and very efficient, and there are no manufacturing difficulties connected with the device.

ELECTRIC TRAFFIC REGULATOR.

(198) S. B. Blair, Marquez, Texas, has an idea whereby he will throw all the traffic cops out of work, his idea being that instead of using a human being, he uses an electro-mechanical machine, and the drawings which he submits as well as the idea of the arrangement are certainly quite plausible, and have a good many points of interest. He proposes to have the regulator entirely automatic; thus he has designed a machine so as to operate signals at intervals of one minute between "stop!" and "go!" reasoning that traffic can thus be regulated by the public itself.

A. While this idea is very good, and while the details have been worked out to perfection, still we do not think that it will be practical, as nearly all machines are wont to leave out the human equation. If the traffic were dense enough and if one driver wanted to get ahead of the other, he certainly would not much mind the indicator, as an indicator has no authority and would not be likely to arrest the offender, and this of course the offender knows; hence, the traffic regulator would probably not regulate at all, and for that reason we are afraid it is of no commercial use.

SELENIUM DEVICE.

(199) W. J. Pinckard, Wray, Colo., has an idea to utilize a paper record on which an impression is made in black and white by human voice, this record to be run like a phonograph record, then when a beam of light is thrown on the record, it is supposted to influence a selenium cell thereby operating the telephone, thus reproducing the human voice. Our advice is asked on the scheme.

A. The device is good as far as it goes, but there is just one hitch. How is the record to be obtained, in the first place, and by what means? Also it would be very difficult to have the record influence the selenium cell in the way described by our correspondent.

AUTOMATIC SOLDERING IRON.

(200) Geo. H. Parkman, Washington, D. C., has submitted to us a soldering iron which carries its own supply of solder. In other words it makes it unnecessary to pick up solder from the bar, and the work therefore could be performed continuously. Our advice is asked.

A. This is really a very excellent idea and as novel as it is good. We think that a good patent could be obtained, as this is certainly an article for which there is a good demand. We would, however, caution our correspondent to first make a model and see how it operates in practise. Would also caution that a soldering iron must be cleaned by means of a file very frequently, and this might be a feature that would tend to clog the flow of the solder more or less. This is worth while looking into.

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FLAT IRON ATTACHMENT.

(201) Mrs. Leslie P. McNeill, Corpus Christi, Texas, submits a novel idea, being a sprinkler arrangement attached to the front of a flat iron. Also suitable container carrying water and the means whereby the flow of the water can be regulated.

A. This is a capital idea and looks to us very practical, but the device has one objection, namely the handle will not hold enough water, and we would suggest using a flexible tube or otherwise mount a reservoir in front of the iron, which would do away with this objection. Otherwise, it looks to us like a very good propostion, and a patent certainly ought to be procured.

FLYING TORPEDO.

(202) Joseph Sear, Philadelphia, Pa., submits an idea of what he calls a flying torpedo, not designed for submarine destroying, but to be used for land batteries traveling thru space under its own power, and to cover a greater distance than the biggest shell. Our advice is asked as to the novelty and feasibility of this scheme.

A. This idea is entirely impracticable, and the scheme as shown by the correspondent cannot possibly work. The power to propel the device would require a power plant so large and so expensive as to preclude the use of the device for practical uses. Also there would not be any way to steer the torpedo, and the chances are that it would not make a hit once in ten thousand. We caution our readers not to spend too much time in developing machines that are entirely controlled by wireless or electricity as hardly any devices of this kind have as yet proved their value.

FREAK TROUBLES—TIPS TO "BUG" HUNTERS.

(*Continued from page* 696)

statements made are facts; secondly and thirdly, let me add to that assurance.

A house-lighting system was in trouble. It seems that the "madam" would receive a shock every time she touched a switch. The trouble shooter looked the system over and reported it O. K. All his tests could locate no "leak" or "short". Still a shock was awaiting the aforementioned lady at each switch.

Again the system was gone over, carefully and with the utmost care. And it was clear, he swore there was no ground, "short", "open" or "leak", or any of the ills to which electrical apparatus are frequently subject. Even so, it did not alter the fact that the lady in question would still receive her shocks.

The electrician was sent again to kill the "bug". Instead of working on the wiring itself, he decided the trouble was elsewhere and sat down to think it over. As he sat there the "madam" past him and as he glanced after her a great light dawned on him. Approaching her, he asked: "Does anyone else in the house experience the trouble you have with the electric light?"

Her reply in the negative clinched his idea. So he made the strange request that she allow one of her maids to wear one of her gowns. He instructed the maid to turn on one of the light switches. As her hand touched the switch a crackle was heard and she stepped back in alarm.

Well, fellow "bug-hunters", have you determined what the trouble was?

Turn to any text-book on electricity and in the chapter on "Static Electricity" you will find the statement *that silk becomes electrified when subjected to friction.* The lady wore silk gowns almost without exception.

As the gown swept along the floor it rubbed against the high pile of the carpet. The electrical charge thus generated would leap to ground when the hand of the wearer was in the vicinity of a grounded conductor. The metal switch plates were all grounded in accordance with the underwriter's ruling on that point. And thus the mystery was solved. The only cure was to wear shorter dresses or to insulate the switch covers.

Electricity may be the servant of Man, as the poets like to have it, but it is chuck full of more tricks than a box of monkeys.

STORAGE BATTERIES FOR ELECTRON RELAYS.

(*Continued from page* 683)

replenishment of the solution with distilled water from time to time. In very small cells, the total liquid content is not sufficient to fill the smallest hydrometer; therefore the specific gravity of such a cell cannot well be ascertained. To remove all the electrolyte from any storage battery cell, when the cell is in a charged condition, will positively injure it; so that hydrometer readings of the electrolyte which are so necessary to keep some types of storage battery in condition are a practical impossibility in miniature cell operation. It is therefore requisite that a type of battery which requires no hydrometer readings should be used, and that such a battery should also incorporate the virtue of not being injured by oft-repeated overcharging, or by standing idle for protracted periods in a charged, semi-charged or, in some cases, totally discharged condition.

It should also be of as light weight as is consistent with rugged constructions.

All these and many more characteristics, so necessary for absolute dependability, are possessed by the new storage battery here illustrated.

This cell consists of a plurality of interconnected positive tubes and a plurality of inter-connected negative pockets, immersed in a solution of caustic potash. The positive tubes are of perforated, nickel-plated sheet steel. These are loaded with alternate layers of nickel hydrat and pure nickel flake. The negative pockets are likewise made up of perforated nickel-plated sheet steel, and are loaded with iron oxid.

The number of tubes and pockets that make up the elements of a cell depends on the capacity required. In the wing circuit of ordinary electron relays the current rarely exceeds a few milli-amperes, and a single positive tube with four negative pockets provide ample capacity. All steel parts, it should be noted, are nickel plated, the plating being welded on.

Two of these cells are combined to form a "twin" cell by connecting their containers together, and grounding the inner positive of one cell and the inner negative of the other to their respective cans.

At the low discharge rates used in electron relay work, the average voltage during discharge of a twin cell is 2.56, and the final voltage, when re-charging becomes necessary, is 2.4. Hence, 16 twin cells are employed for a 40-volt battery and 42 for a 110-volt battery.

The ampere-hour capacity of one of these cells is 1.25, and the normal charging rate 0.25 amperes. Hence, under normal conditions, the time of charge is five hours; but in an emergency, the normal charging rate can be greatly exceeded, without injuring the cell. The low discharge rate in the wing circuit enables a battery to run from several hundred to several thousand hours continuously, on one charge, depending upon the characteristics of the relay bulb.

Obituary

WILLIAM DUDDELL.

It is with very great regret that we record the death of William Duddell at the early age of 45. He past away on November 4, and his death will come as a shock to those who have not been aware of his failing health during the past year.

William Duddell was born in London in 1872, and after education at private schools and at the Collège Stanislas, Cannes, he served his apprenticeship with Messrs. Davey, Paxman & Co., of Colchester, England, from 1890 to 1893. He then went to the City and Guilds Central Technical College at South Kensington, where he studied from 1893 to 1900 under the late Prof. Ayrton, obtaining a Whitworth Exhibition in 1896 and a Whitworth Scholarship in 1897. In 1913 the Fellowship of the City and Guilds of London Institute was conferred upon him. He remained at the college considerably longer than usual, engaged in original experimental work, and it soon became apparent that he possest unusual talent as an experimentalist.

In 1898 he read, in conjunction with Mr. (now Prof.) E. W. Marchant, a paper before the Institution of Electrical Engineers, entitled "Experiments on Alternating-current Arcs by Aid of Oscillographs." It was on this occasion that he showed the *oscillograph* which has become so markedly identified with his name, and which he developed into one of the most useful instruments for investigating transient electrical phenomena that has been placed in the hands of the physicist and engineer for many years.

Two years later Duddell read a paper, also before the Institution of Electrical Engineers, on "Rapid Variations of Current Thru the Direct-current Arc." In this classical paper he described the *musical arc*, which he found to act as a generator of high-frequency currents. This paper was of fundamental importance, showing how undamped oscillations could be produced; but its full significance was not immediately recognized, partly, no doubt, because the frequency of these waves was not very high.

In connection with wireless telegraphy may also be mentioned his discourse to the British Association on "Arc and Spark in Radio Telegraphy," his discourse on "High Frequency Currents" before the Royal Institution, and his Christmas juvenile lectures before the same Institution on "Signaling." He also described a variable condenser with a square law in a paper publisht in the "Journal" of the Institution of Electrical Engineers.

Duddell was an active member of many societies. After having past thru all the then grades of Membership, Student, Associate, Associate Member and Member, Member of Council and Vice-President, he was elected President of the Institution of Electrical Engineers at the early age of 40, holding office for two years in succession. His first presidential address was of the orthodox kind, but the second gave his audience a rare opportunity of witnessing instructive experiments on "Pressure Rises" most skilfully performed.

Among the apparatus then shown was an electro-mechanical model of the arc, which was a most ingenious device for reproducing mechanical analogies of the various well-known and somewhat puzzling characteristics exhibited by the electric arc. The up-to-date nature of the Institution library, which was by no means its character some few years ago, was largely due to the efforts of Duddell as chairman of the Library Committee. In 1907 he was president of the Röntgen Society. For a time he was a vice-president of the Physical Society, and was hon. treasurer of the So-

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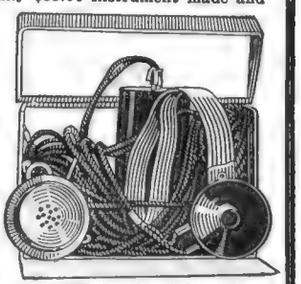

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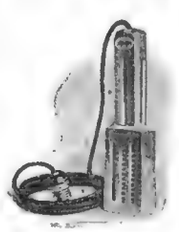

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ciety from 1910 up to the time of his death. He was hon. secretary to the delegates to the International Electrical Congress at St. Louis in 1901, and one of the hon. secretaries to the International Conference on Electrical Units and Standards which met in London in 1908. He was also president of the Commission Internationale de Télégraphie sans Fils, and in 1914 he publisht an outline of the investigations contemplated by that body, but which were, unfortunately, interrupted by the calamity of war.

Among his honors may be mentioned gold medals for his oscillographs at the Paris Exhibition of 1900 and at St. Louis in 1904; and the Hughes medal of the Royal Society in 1912. He was elected a Fellow of the Royal Society in 1907. He was a member of the Advisory Council for promoting Industrial and Scientific Research, and of the Board of Inventions and Research of the Admiralty. Recently the honor of Commander of the Order of the British Empire was bestowed upon him, but it will generally be felt that his name should have appeared in some more distinguished class.

Altho the value of his work was quickly recognized, he always remained unassuming, and his lightness of manner made him readily approachable by all and sundry. Being unmarried, he gave himself unreservedly to his work; and it may indeed be said that this was his only hobby, which made it all the more difficult for his friends to induce him to put work aside when it became evident that his health was failing. The end came suddenly, and those who knew him will feel some relief that it should have been so. He will long be remembered as a brilliant experimentalist, to whom the electrical industry owes a debt of gratitude, and whom the electrical profession can ill afford to lose.

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"GARABED" TO CONGRESSIONAL NOTICE THIS SESSION.

Not discouraged by the fact that President Wilson killed the "Garabed" Free Energy bill by a pocket veto last session, Garabed T. K. Giragossian, the Naturalized Armenian from Boston, has appeared early in Washington, and will bring his Free Energy bill to the surface again.

Congress will be asked again to provide for a demonstration of his invention with the intent of turning over the patent to the Government for use during the war. Mr. Giragossian said that he had the assurance of a number of leading congressional members that provision would be made for the necessary demonstration at this session.

35 POUNDS OF SUGAR KEEPS ELECTRIC PLANT FROM CLOSING.

Officials of the Westinghouse Lamp Company of Bloomfield, N. J., which employs 3,500 workers, appealed recently to Federal food authorities for thirty-five pounds of brown sugar, saying it would be necessary to suspend operations unless the request was granted. It was explained that brown sugar is used in infinitesimal quantities in making electric light globes. The Food Administrator gave assurances that the quantity desired would be made available each week.

ELECTRO-CHEMISTRY.

(*Continued from page* 700)

An ion is not a simple atom, or radical, as one might at first suppose. It is more; *it is the atom or radical plus a certain charge of electricity;* it has properties different from the atom; sodium and chlorin atoms are represented as Na and Cl; their ions as, Na^{+} and Cl^{-}.

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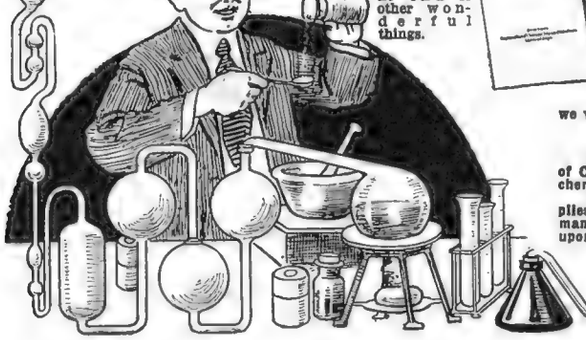

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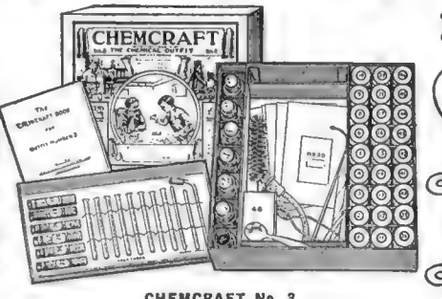

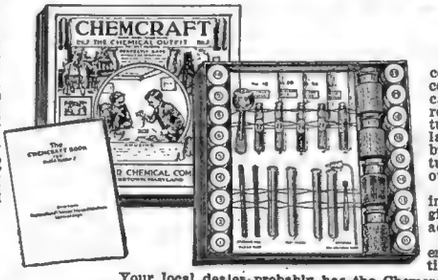

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ionized, if the solution contained simple atoms or molecules of sodium, the latter would at once react with the water and form sodium hydroxid; the charge of electricity which the Na ion carries, prevents this action. It is a sodium *ion*, not a sodium *atom*. The same explanation applies to the chlorin ion. When the current is passing and sodium ions are deposited on the electrode, they lose their electric load and act as atoms of sodium. For this reason Davy found in 1807, when he electrolyzed sodium hydroxid (NaOH) in solution, that he got no sodium. When he fused sodium hydroxid and used no water he obtained metallic sodium. The same thing is true in the electrolysis of other substances; ions become atoms or radicals and no longer act as ions, but behave as such atoms or radicals ordinarily do in the given solution. If there is nothing which reacts with them, they are deposited if solids, or set free if gases.

We have said that *anions* were charged with negative electricity and *cations* with positive; not only this, but during the passage of a current they are carriers of electricity to their respective electrodes. The non-ionized molecules of a solute do not act as carriers; only the ions so act. This explains why non-electrolytes like sugar or water are non-conductors, for they have no ions.

IONIZATION INCREASES WITH DILUTION:

The conductivity of a solution is dependent upon the degree of ionization; for example, if only 90% of a solution is ionized, the solution is less of a conductor than if 100% is ionized. Conversely, *the conductivity of a solution becomes a measure of the degree of ionization.* This is, in fact, the test of the relative degrees of ionization. The more dilute the solution, up to a certain point, the greater the conductivity. Acids dissociate into hydrogen ions and the residual minus ions, bases into metallic ions and OH ions, salts into metallic and non-metallic ions.

A small amount of a substance in a given volume of a solution is ionized to a greater degree than is a large amount of the substance in the same volume; by way of illustration: In a dilute solution of sodium chlorid there is a greater proportion of dissociated molecules of the solute than in a more concentrated solution. At a definite limit of dilution the ionization attains its maximum value, as shown by its electric conductivity. Beyond this point the conductivity does not increase with further dilution. (This maximum point varies with different electrolytes, but it indicates that at this particular point of dilution all the solute has became ionized, that there are no free molecules of the solute, and this is an important thing.

There are certain laws and conditions which govern electrolytic action, and it is obvious that a thoro knowledge of these must be had in order to successfully perform such operations.

The amount of chemical action is equal at all parts of the circuit. If two or more electrolytic cells should be placed at different points of a simple circuit, the amount of chemical action would be the same in all, for the same quantity of current would flow past every point of the circuit in the same time. If these cells should contain acidulated water, and others contain copper sulfate, the weights of hydrogen and of copper will not be equal, but will be in chemically equivalent quantities.

The amount of substance liberated at an electrode in a given time is proportional to the strength of the current. Thus a current of two amperes will cause just twice the quantity of chemical decomposition to take place as a current of one ampere would do in the same period of time.

FARADAY'S LAW AND ELECTRO-CHEMICAL EQUIVALENTS.

In studying the quantitative results of electrolytic action Faraday arrived at the conclusions which are now summarized and known as *Faraday's law,* and are fundamental for all calculations in connection with electro-chemical. work. *The same quantity of electricity passing thru an electrolyte either sets free or transfers to other combinations always the same number of valencies.* Illustration:—A given current (that is, a given number of coulombs of electricity) past thru a given solution of silver nitrat would set free twice as many silver atoms as the same quantity of electricity would of copper atoms in a similar solution of copper nitrat. The silver ions may be said to have one charge of electricity (having valence 1) whereas the copper ions have two charges (valence 2). These are written Ag^{+} and Cu^{++}. The corresponding minus ions would be written NO_3^{-} and NO_3^{--}. Thus the quantity of electricity that would deposit one atomic weight of copper will in the same time cause to deposit two atomic weights of silver. It acts the same as the chemical reaction: $2AgNO_3 + Cu = Cu(NO_3)_2 + 2Ag$. Two atoms of silver are deposited, one atom of copper taking their place.

The amount of substance liberated at an electrode in one second is equal to the strength of the current multiplied by the "electrochemical equivalent" of that substance.

The passage of one coulomb (the quantity of electricity conveyed by a current of one ampere in one second; amperes × seconds = coulombs) of electricity thru a solution of silver nitrat liberates 0.0011183 gram of silver. Hence a current of i amperes will liberate i × 0.0011183 gram of silver per second. The number 0.0011183 is the *electrochemical equivalent* of silver. The electrochemical equivalents of other elements may be easily calculated if their *chemical equivalent* is known:

$$\frac{\text{Atomic weight}}{\text{Valency}} = \text{Chemical Equivalent}$$

Thus the chemical equivalent of hydrogen is 1.008 while that of silver is 107.88. Hence the electrochemical equivalent of hydrogen will be 0.0011183 × 1.008 ÷ 107.88 = 0.00001044.

The *chemical equivalent* must not be confused with the *atomic weight.* The atomic weight of copper is 63.57; that is its atoms are 63.57 times as heavy as atoms of hydrogen. But in chemical combinations one atom of copper replaces, or is equivalent to, two atoms of hydrogen; hence the weight of copper equivalent to 1 of hydrogen is 63.57 ÷ 2 = 31.78, the chemical equivalent of copper.

All atoms that are univalent carry exactly the same minute quantity of electricity; all atoms that are divalent carry exactly twice that amount; all trivalent atoms carry three times that amount. Every atom conveys a quantity of electricity proportional to its valence, *not to its weight.*

Every electrolyte is decomposed into two parts, as stated before, an *anion,* and a *cation,* which may be themselves either simple or compound. In the case of simple binary compounds, the ions are simple elements. In other cases the products are often complicated by secondary actions.

In binary compounds and most metallic solutions, the metal is deposited by the current where it leaves the cell, at the cathode.

Aqueous solutions of salts of the metals of the alkalies and alkaline earths deposit no metal, but owing to the secondary action of the metal upon the water, evolves hydrogen.

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You are going wrong. Can't you feel it? Others see it and it's about time for you to call a halt in your ways — and, quick-step into condition! You can't get vital health and energy and vim and ginger out of a pill box or bottle. You know where you are going and it's time to back-pedal for all you are worth; you want to be a man in every sense of the term, don't you? You want to be the kind of man that the moment one lays eyes on you, he senses you are a man, a man strong, forceful, vigorous; glowing with health and strength; the kind of strength greater than muscular strength; the strength that, once acquired, compels you to

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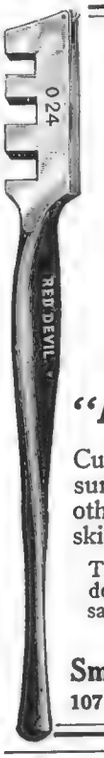

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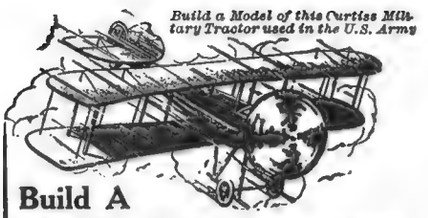

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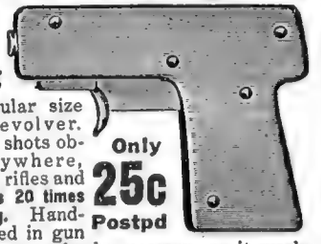

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Electrochemical Character of Elements.

Negative end

Oxygen	Tin	Zirconium
Sulfur	Hydrogen	Aluminum
Nitrogen	Gold	Scandium
Fluorine	Osmium	Erbium
Chlorine	Iridium	Yttrium
Bromine	Copper	Ytterbium
Iodine	Uranium	Beryllium
Selenium	Bismuth	Magnesium
Phosphorus	Gallium	Calcium
Arsenic	Indium	Strontium
Chromium	Germanium	Barium
Vanadium	Lead	Platinum
Molybdenum	Cadmium	Rhodium
Tungsten	Thallium	Ruthenium
Boron	Cobalt	Palladium
Carbon	Nickel	Mercury
Antimony	Iron	Silver
Tellurium	Zinc	Lithium
Tantalum	Manganese	Sodium
Columbium	Lanthanum	Potassium
Titanium	Cerium	Rubidium
Silicon	Thorium	Caesium

Positive end

In the above table, the principal elements are arranged according to their electro-chemical character, each atom being *positive* to any atom placed above it and *negative* to any atom placed below it.

From a solution of mixt metallic salts the least electro-positive metal is not deposited first, if the current is so strong relatively to the size of the cathode as to impoverish the solution in its neighborhood. To deposit alloys, a solution must be found in which both metals tend to dissolve with equal electromotive-forces.

The liberated ions appear only at the electrodes.

For each electrolyte *a minimum electromotive force* is required, without which complete electrolysis cannot be effected.

If the current be of less electromotive-force than the required minimum, electrolysis may begin, and a feeble current may flow at first, but no ions will be liberated; the current being completely stopt as soon as the opposing e.m.f., of polarization has risen to equality with that of the electrolyzing current.

There is no opposing electromotive-force of polarization when electrolysis is effected from a dissolving anode of the same metal that is being deposited at the cathode. The feeblest cell will suffice to deposit copper from copper sulphate *if the anode is a copper plate.*

Where the ions are gases, pressure effects the conditions but slightly. Under 300 atmospheres acidulated water is still electrolysed; but in certain cases a layer of acid so dense as not to conduct collects at the anode and stops the current.

The chemical work done by a current in an electrolytic cell is proportional to the *minimum* electromotive-force of polarization.

Altho the electromotive-force of polarization may exceed the minimum, the work done by the current in overcoming this surplus electromotive-force will not appear as chemical work, for no more of the ion will be liberated; but it will appear as an additional quantity of heat (or *local heat*) developed in the electrolytic cell.

Experiments show that the resistance of a given column of a specific electrolyte is a constant, no matter whether larger or smaller currents are used in testing the resistance.

Amongst the secondary reactions which may occur the following are the chief:

[1] The ions themselves may decompose; as SO_4 into $SO_3 + O$. [2] The ions may react on the electrodes; as when acidulated water is electrolysed between zinc electrodes, no oxygen being liberated owing to the affinity of zinc for oxygen. [3]

Attention Experimenters!!

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The ions may be liberated in an abnormal state. Thus oxygen is frequently liberated in its allotropic form as *ozone,* particularly when the permanganates are electrolysed. The *nascent* hydrogen liberated by the electrolysis of dilute acid has peculiarly active chemical properties. So also the metals are sometimes deposited abnormally; copper in a black pulverulent film; antimony (from the terchlorid solution) in round grayish masses which are possessive of a curious explosive property.

When a solution of lead is electrolysed a film of lead peroxid forms upon the anode. If this be a plate of polished metal placed horizontally in the liquid beneath a platinum point as a cathode, the deposit takes place in symmetrical rings of varying thickness, the deposit being thickest at the center. These rings, known as Novili's rings, exhibit all the tints of the rainbow, owing to interference of the waves of light occurring in the film. The colors form, in fact, in reversed order, the "colors of thin plates" of Newton's rings.

[4] In certain cases the deposit may be of a non-conducting nature, as, for example, when aluminum is the anode in an alkalin solution, and an oxid of aluminum is formed as a film which entirely stops the current. Hence if a cell is arranged with a small plate of aluminum and a large plate of lead, which are immersed in a solution of sodium carbonat or ammonium phosfate, a current can flow thru it from lead to aluminum, but not from aluminum to lead. Such a cell, known as Nodon's valve, conducts in one direction only, and can be used to rectify an alternating current.

Equilibrium and Balance.

In order to have *equilibrium* it is quite evident that there must be the same number of *negative* as of *positive* ions in a solution. This serves to explain why a salt readily soluble in water, is not so soluble in water containing other compounds having some of the same ions in solution. For example, upon the the addition of hydrochloric acid to a strong solution of barium chlorid, a precipitat of barium chlorid is formed. This is usually explained by saying that barium chlorid is less soluble in hydrochloric acid than in water; the ionic explanation is that there is an excess of chlorin ions when hydrochloric acid is added to barium chlorid, equilibrium is upset, and hence a precipitat continues to fall until equilibrium is again establisht. The same effect is produced upon the addition of sodium chlorid solution to one of barium chlorid, and in general when there is an excess of one or another ion. The more concentrated either or both of these solutions are, the more rapid and complete the precipitation. This leads on to the *Mass-Action Law.*

Mass-Action Law.

The rate of chemical change between two reacting substances is directly proportional to the concentrations of the two substances reacting.

By way of illustration: let us see from the modern theory of solution what is supposed to take place when a solution of sodium chlorid is added to one of lead nitrat. Theoretically, no less than eight substances are present, as follows: Pb $^{++}$ $(NO_3)_2$, $^{+}$ Na $^{-}$ Cl, $^{++}$ Pb, and $(NO_3)_2$. $PbCl_2$, by reason of its comparatively insolubility, is mostly precipitated. Not being wholly insoluble a portion remains in solution. According to the concentrations of the two factors, so will be the rapidity of precipitation of $PbCl_2$, and consequently more or less rapid establishment of equilibrium of the solution. If in a solution, all the substances are in equilibrium, no chemical action takes place. Disturbance of that chemical equilibrium produces a reaction. Adding more of either factor disturbs the poise. Taking away either of the products produces the same thing, each giving a *molecular concentration,* which causes increased action. This is the gist of the *mass-action law.*

Migration of Ions.

Prepare the apparatus shown in the photograph Fig. 102 from the constructional details given in Fig. 101. Pass one wire containing the copper disc thru a cork which fits tightly into the test tube (to prevent dripping of solution) and then fasten a binding post to the end. This serves as one electrode. Fill the tube three quarters full with a strong solution of copper sulfate slightly acidulated, which solution serves as the electrolyte. Place the upper cork, which has been previously fitted with an electrode, in the same manner as the first one. The upper electrode, which will be considered as the cathode, should be immersed about an inch beneath the solution. The other, the anode, should come within a couple of inches below the cathode as shown. The current from a few battery cells is then sent *UPWARDS* thru the electrolyte, the current being so regulated that it is not too strong, otherwise bubbles of gas will be given off and throw out the experiment. Of course, copper will be deposited *on* the cathode plate, an equal amount of copper being dissolved *off* the anode. After half an hour or more it will be seen that, immediately beneath the cathode, the blue liquid will become quite colorless, and if the experiment is continued, the surface of separation between the colorless liquid at the top and the blue liquid beneath it will be found to have steadily moved downward. If the current is sent *downward* thru the cathode, instead of upward thru the anode, no such phenomena can be seen, due to the descent by gravity of the heavier blue liquid. The colorless liquid is simply acidulated water.

There are two ways of explaining the action which has taken place. The first is that, in some way, in addition to the ordinary electrolysis in which the Cu and SO_4 ions have transferred in opposite directions, there has been a bodily transfer toward the anode of the copper sulfate which was in solution. The other way of explaining this is that the Cu and SO_4 ions have traveled with different velocities, the Cu traveling upward more slowly than the SO_4 downward. In the sketch Fig. 103, on both sides are some rows of dots, the black dots showing the *cations* (Cu) and the white ones the *anions* (SO_4), for the purpose of illustrating the relative number of the ions in the upper and lower portions of the liquid. Before electrolysis began the solution was uniform, as shown on the left, there being 9 anions and 9 cations (that is, 9 of $CuSO_4$) in each part, upper and lower. Suppose that electrolysis has gone on for so long a time that 6 of the cations have been dissociated and plated on the cathode, and that 6 of the anions have been likewise liberated and carried down to the anode, there to combine with the copper. Now, if the observed state of things is represented by the diagram on the right, it will be seen that while in the upper layer there are 5 $CuSO_4$ molecules, in the lower there are 7 $CuSO_4$ molecules, together with the 6 SO_4 which have gone to dissolve fresh copper. If the migrations of anions and cations had been equal, there would have been 6 $CuSO_4$ in each layer. If the anions alone had migrated, downwards, there would have been 15 $CuSO_4$ below and 3 $CuSO_4$ above. If the cations alone had moved, upwards, there would have been 9 $CuSO_4$ in the upper layer, leaving 3 of the original $CuSO_4$ in the lower, together

(*Continued on page 729*)

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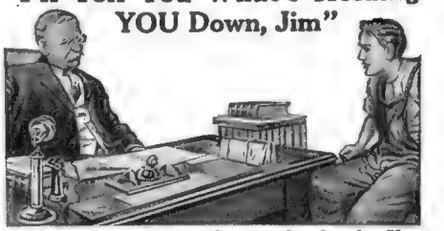

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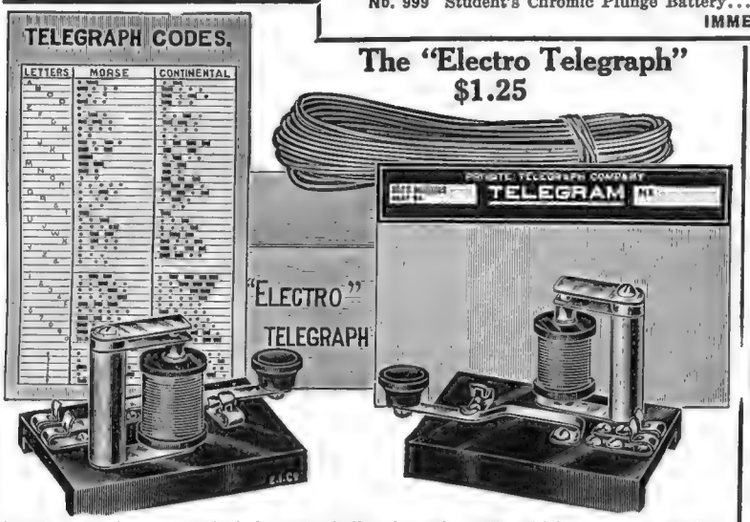

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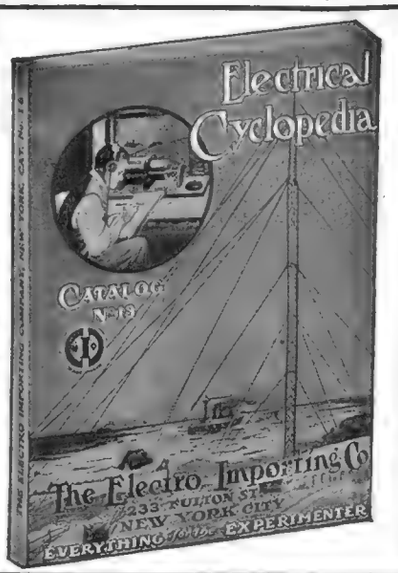

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ELECTRO-CHEMISTRY.

(*Continued from page 727*)

with the newly formed 6 $CuSO_4$. If, however, the diagram on the right represents the facts, either 2 $CuSO_4$ must have been bodily transferred into the lower layer from the upper, or else the transfer of ions must have been unequal; 4 anions going downwards into the lower layer, while 2 cations have gone upwards into the upper layer.

Theory of the Current in Electrolysis.

To get a picturesque illustration of what takes place when a current is past thru a solution of sodium chlorid (common salt), let 1, 3, 5, 7, 9 (Fig. 104) be five sodium ions, and 2, 4, 6, 8, 10, five chlorin ions, each ion having its charge of electricity neutralized by the ion above or below before the current is past, 1 being balanced by 2, 3 by 4, etc., and the solution being in equilibrium is disturbed by the passage of a current from a source of electricity. The plus ion 1 is then attracted to the cathode, where its plus charge neutralizes a part of the minus electricity of the cathode and ion 1 becomes an atom of sodium (see Fig. 105). The cathode then repels minus ion 2, and the latter attracts 3 and leaves 4 unbalanced, which in its turn attracts 5, leaving 6 to attract 7, which leaves 8 to attract 9; 10, being then unbalanced, is attracted to the anode, and losing its charge to the anode, becomes an atom of chlorin. The operation is repeated with almost infinite rapidity, atoms of sodium being set free at the cathode and of chlorin at the anode. Each unites with atoms of its fellows to form molecules of sodium and molecules of chlorin. The chlorin having nothing to combine with, escapes as a gas and may be collected. The sodium, of course, reacts with the solvent water to form sodium hydroxid and liberates hydrogen. Advantage is taken of this reaction in the manufacture of NaOH. This series ot reactions takes place instantaneously and continuously.

(*To be continued*)

THE HOW AND WHY OF RADIO APPARATUS.

(*Continued from page* 685)

neutralize the other and minimum inductance will be had in the instrument. Theoretically considered, if coil "A" produced a magnetic flux density of 1,000 gausses per square centimeter of core section, then if this was opposed by 1,000 gausses of flux per square centimeter, of *opposite* polarity, the resultant magnetic flux, reacting on the coils will be zero. If the flux of 1,000 gausses per square centimeter of coil "A" is aided by the *like* flux due to coil "B," then the resultant flux acting on the coils will be 2,000 gausses per square centimeter. [For calculating the inductance of both long and short single layer as well as multilayer radio coils, reference should be made to the March, April and September, 1917 issues of the ELECTRICAL EXPERIMENTER, containing Parts I, II and III of a complete series on the *"Calculation and Measurement of Inductance."* See also "Wireless Telegraphy and Telephony Hand-book," by Dr. W. H. Eccles; "The Calculation and Measurement of Inductance and Capacity," by W. H. Nottage, B. Sc.; Bulletin of the Bureau of Standards, Vol. VIII, No. 1, page 64, for formulae covering the calculation of self as well as mutual inductance.]

Fig. 5 shows how the so-called *loose coupler* transfers the antenna circuit oscillations to the detector circuit by electromagnetic induction. The farther the secondary coil is separated from the primary the smaller the number of flux lines linking the secondary turns, and the less the mutual induction between the coils. With the secondary coil all the way within the primary, the strongest signals will be heard usually, but owing to interference from other stations, static, etc., it is often found in practise that the signals are heard best with a relatively loose coupling, or with the secondary considerably removed from the primary. At the Sayville, L. I., station, signals from Germany have been received with 2 to 4 foot of coupling separating the primary and secondary. The coupler coils were quite large of course, or about 20 inches long. The September, 1917 issue of the ELECTRICAL EXPERIMENTER contained the rules and formulae for designing both large and small loose couplers.

Loose couplers, as well as tuning coils, variometers, etc., should preferably always be designed to handle the wave lengths to be tuned in. If the range of frequency is quite large then two loose couplers forms the best solution of the problem; a small one for short and medium wave lengths and a large one for higher wave lengths. Loading coils, generally speaking, are a source of loss and are to be avoided. They offer considerable resistance to the weak antenna currents and cannot transfer energy to the detector circuit, except indirectly, such as by bringing the aerial or open oscillating circuit into resonance with the incoming wave. This, of course, causes a maximum flow of energy thru the antenna circuit, which, under many conditions, will effect a sufficient transfer of energy to the detector circuit to operate the responsive devices therein. This explains why the erstwhile Radio Amateur was forever building gigantic *loading coils*. He had found that his fellow "Radio-bug" could hear "Nauen" or "Honolulu" on his receiving set consisting of an 800 meter loose coupler coupled up with a *loader* made of a cardboard tube 9 feet long, wound with a mile or so of No. 36 silk covered magnet wire. He heard these far distant stations not because of good tuning conditions but rather in spite of poor tuning; this was often due also to the superior sensitivity of the Audion or other amplifier used, over which he exercised no control.

This argument is the same as that for charging 6 volt storage batteries with a bank of lamps (or a rheostat) from a 110 *volt* circuit. If you are going to charge the 6 volt battery in that way, well and good; but don't forget that the energy expended in lighting up the bank of lamps is forever wasted and it does the battery no good whatever. The moral is—use a low-voltage charging dynamo, driven by a water wheel or small engine, or a well designed rectifier if alternating current is available. Likewise, if long waves are to be tuned in, use a large enough loose coupler and put all of the energy to work. For short or medium ranges, a loading coil is often satisfactory because of the superior strength of signal received.

Diagrams Figs. 6, 7, 8 and 9 illustrate four of the principal tuning schemes in use to-day for receiving radio signals, Figs. 6 and 7 for the reception of damped waves and Figs. 8 and 9 for interpreting undamped wave signals, such as sent out by stations employing the Poulsen arc or a Goldschmidt (or Alexanderson) radio frequency alternator.

Fig. 6 outlines the connection of the Marconi *magnetic detector*. It is tuned in either by a tuning coil in series with the aerial or it may be connected in the secondary circuit of a loose coupler. It is connected in the tertiary circuit of the Marconi multiple tuner, the fixt or blocking condenser being variable and the tertiary winding of low

(*Continued on page* 731)

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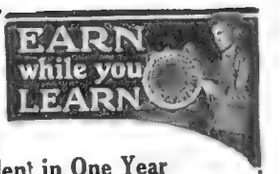

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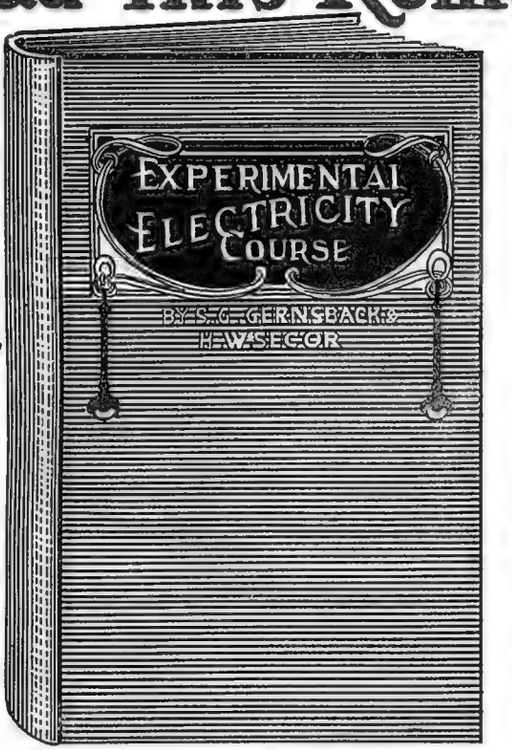

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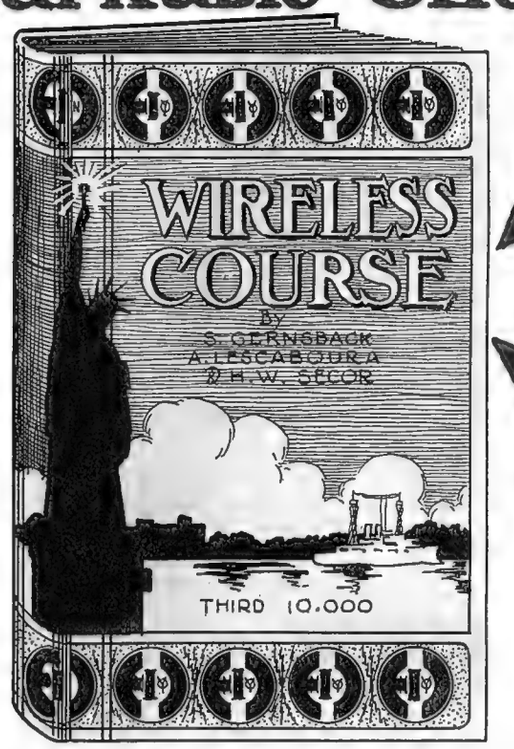

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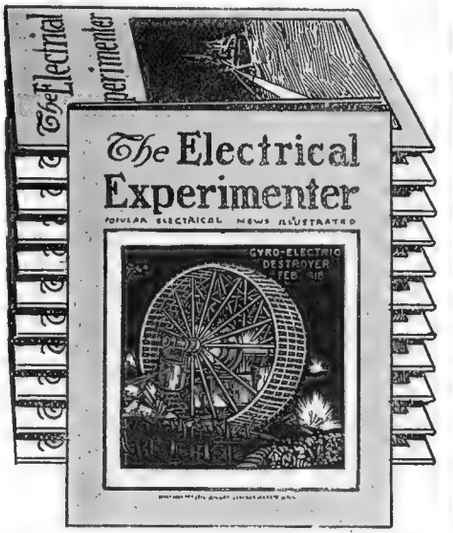

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THE HOW AND WHY OF RADIO APPARATUS.

(*Continued from page 729*)

resistance; i. e., wound with relatively coarse wire. Low resistance 'phones (75-80 ohms each) are used with this detector.

Fig. 7 is the hook-up for a standard *damped* wave Audion receptor. The loose coupler secondary should have high resistance; i. e., many turns of fine wire, so as to give a relatively high potential, as this detector is a potentially operated type. It is remarkably sensitive and many times more efficient than any form of crystal detector. High resistance 'phones are used with this layout of apparatus, and the battery polarities should be watched carefully.

Diagram Fig. 8 shows how the Poulsen *tikker* should be hooked up for receiving *undamped* wave signals. In one instance, cited by deForest, the tikker (interrupter) made from 150 to 200 breaks per second (the tone is regulated by the tikker speed); the 'phones comprising two ordinary 75 ohm receivers in series were shunted by a paper and tinfoil condenser of .02 microfarad. The same authority also found that a crystal detector could be used, as shown in diagram, if desired, but that while it raised the pitch of the incoming signals, it also reduced the strength of the signals on long ranges. A buzzer or gold wire tikker is indicated here, but the Poulsen stations now use a rotary wheel tikker, driven by a motor. A light spring wire brush rests in a groove filed in the perifery of the revolving disc. The action of the tikker is to allow the radio frequency energy to pile up in the large capacity connected across the secondary of the loose coupler; this periodically discharges into the condenser connected across the 'phones and which capacity in turn discharges thru the 'phones.

Diagram Fig. 9 shows a regenerative hook-up for a single Audion, whereby damped as well as undamped signals can be received. The November, 1915, issue of this journal contained full details of this interesting circuit and the work accomplisht with it.

The layout in Fig. 9 consists virtually of a loose coupler, primary and secondary loading coils and three variable condensers connected to an Armstrong circuit. The dimensions of the inductance coils are as follows: Primary of coupler is 10 x 5 inches and is wound with No. 22 S. S.; the secondary is 10 x 4¼ inches, wound with No. 28 S. S.; the secondary loading coil SL is 22 x 3½ inches and wound with No. 30 S. S., while the wing inductance WI has No. 30 S. S. for its winding. The capacity of each condenser is given in the diagram.

An aerial successfully used with this set measured 600 feet long, the wires starting 10 feet apart and ending 18 inches apart (fan shaped), the average height being about 50 feet. With this set it was possible to tune to 4,000 meters without any aerial inductance coils, and if loading coils are connected in the circuit it became possible to receive stations of over 9,000 meters wave length.

A simple Audion regenerative circuit, especially suitable for amplifying spark signals of wave lengths above 200 meters is shown in Fig. 10. The additional or *tickler* coil is a small auxiliary inductive coupler and connected as shown. It is used to interlink magnetically the wing and grid circuits. Remarkable amplification is obtainable with this scheme. It is being more widely adopted every day in commercial practise and many of the Army and Navy receiving sets are fitted with the tickler coil arrangement. The U. S. Navy specifications call for it. The superiority of the variable coupling tickler coil is that the device will always respond in a regenerative manner, while the circuit shown at Fig. 9 is more or less dependent upon certain critical conditions in the circuit for its successful operation. The hook-up shown at Fig. 10 is adapted to the reception of undamped as well as damped (spark) stations.

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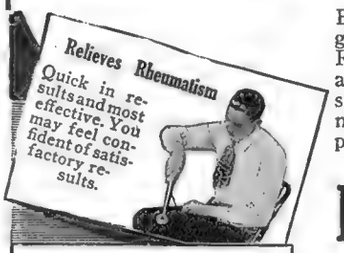

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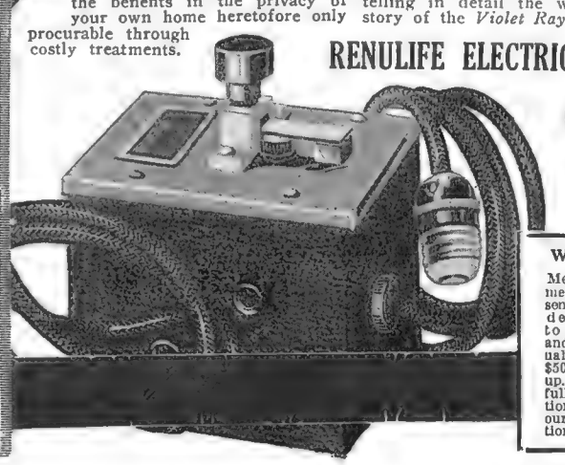

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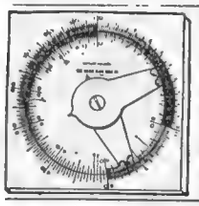

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NEW ORCHESTRA PHONOGRAPH PLAYS 48 RECORDS AT ONCE.

(*Continued from page 662*)

ers and thence over a sprocket wheel onto the take-up drum at the other lower end of the instrument as shown, which resembles an organ as far as its outside appearance is concerned. The sprocket wheel which engages perforations of the film similar to a motion picture machine and the take-up drum are driven by belts from an electric motor mounted directly upon the floor, with layers of felt placed between to subdue the hum.

Each needle of the various diaframs engages another sound record line and from each diafram leads a tube or sound-arm into a corresponding resonance compartment or horn, these being arranged partly above and partly below the channel rail. Between the two lower compartments which house the pay-out and take-up drums a space is provided for additional reels of film. A film of 1,500 feet length will play continuously for more than one hour, as the film moves only with a speed of 5" per second.

All diaframs can be lifted simultaneously with one lever so as to facilitate the insertion of a new film, the first few feet of which has to be pulled thru the perfectly smooth channel guide plate and attached by one end to the take-up drum. Otherwise the position of the various diaframs is absolutely a fixt one and cannot change relatively to each other, resting freely upon the film with the needle in a certain sound line. Saffire or diamond needles are used which do not require changing. As the film is not elastic and all sound records are at a certain fixt position to each other, corresponding to the position of the diafram engaging a particular record line, it is obvious that thus a perfect synchronism is attained, which never can be disturbed and the instrument can thus produce all the various sounds in perfect harmony with each other.

The action of this device will be understood from the foregoing description. If for instance the first diafram engages the first one of the parallel-running sound-record lines and the same contains all the sounds of the first violin of an orchestra exclusively and no others, we would hear only a violin solo if all the other sound-boxes (diaframs) were lifted from the film; while we would hear the complete orchestra playing in perfect harmony if all the different diaframs are engaging with their respective needles the various sound-record lines on the film. It would not be exactly necessary to use as many independent diaframs as there are instruments actually represented in a particular orchestra, as for instance all similar instruments producing sound waves of equal or similar length could be recorded with one sound record. Only where the variation in vibrations of a diafram to reproduce particular sounds is relatively great, would special sound lines and corresponding diaframs be required. Thus an orchestra of say about fifty musicians could be perfectly reproduced with an instrument of this kind, having, perhaps, only twenty-four sound-record lines on the film and twenty-four independent diaframs.

This instrument will, of course, play just as many times louder compared to an ordinary gramophone as it has diaframs, and the original music will be reproduced with a surprising perfection; it being difficult to

distinguish it from the music of an actual complete orchestra consisting of many musicians.

Therefore, this instrument will be excellently suited for motion picture houses, theatres and music halls without requiring even the permanent attention of a single person, except the changing of the film every hour, which can be done by anybody, requiring no skill whatever. Just push the electric button and a complete orchestra playing whole operas or other selections is at your service.

HOW JIMMY SAVED THE TROOP TRAIN.

(*Continued from page* 679)

This done, there remained nothing else but to wait. At this point, feverish doubts began to fill Jimmy's mind. "Would it work as he thought, or suppose the track circuit were not in order?" he questioned himself again and again, as he laid there fascinated by the distant headlight of the oncoming locomotive which loomed larger and larger.

Then like the shrill scream of an enraged eagle, the whistle of the locomotive suspended the silence of the night. A cry came to Jimmy thru the chill night air, for it meant that the engineer had seen the signal, brought his train to a standstill and was now trying to ascertain the cause of the delay.

The realization that his effort to save the train had been successful brought on not only a mental but physical re-action on Jimmy, who in spite of his brave efforts to fight against the weakness, promptly fainted.

The sound of voices and the pattering of many feet were his first recollections on coming to. Opening his eyes finally, he saw that he was the center of a khaki-clad group, one of whom, on seeing his return to consciousness, stept forward and inquired if it were he who had stopt the train and why. Whereupon Jimmy explained as briefly as possible how he had overheard the plot to wreck the train and the plan by which he had succeeded in setting the signal against the engineer. On hearing the narrative, those about him were astounded not only at the narrowness of their escape from death, but at the quick wit displayed by Jimmy in thinking of such a novel plan as the short-circuit idea.

"Young man," spoke up one of them, whose eagle insigna showed him to be the colonel in command of the regiment, "what you have done I consider to be the cleverest bit of ingenuity that I have come across in a long while. Uncle Sam could find a good deal of use for one of your type in the engineer or signal corps. Let me have your name. Such work as you have performed to-night must not go unrewarded."

In the meantime an investigation had been made and resulted in the discovery of a huge quantity of dynamite and nitroglycerine contained in a metallic shaped receptacle so designed that by means of a protruding lever the whole would be detonated when the same was struck by the front wheel of a locomotive. No delay was lost in removing this menace from its dangerous position after which it was placed temporarily at a safe distance in a field nearby.

Also in order to apprehend the three conspirators, a detachment of soldiers was sent forward and soon afterwards they returned with the culprits in their midst, who were subsequently handcuffed and placed in the baggage car with a heavy guard over them.

One morning, as he came limping into the office to relieve his friend Jack Godfrey, who it will be remembered had joined the Signal Corps but had not as yet been called for active service, the latter excitedly handed him two business-like letters which he stated were left by the mail train that morning.

"Why," exclaimed Jimmy, as he looked at the printed matter in the left-hand corner, "what can this mean? Here's one from the Railroad Company and another from the War Department. Must be some mistake."

"Well," replied Jack, "there's only one way to find out and that is to open them."

Jimmy obediently proceeded to do so, in the order named and, imagine his delight and astonishment to read as follows:

My Dear Sir:

In recognition of the great service which you rendered the Company and the nation as well, in frustrating an enemy plot to wreck a troop train which recently past over our lines, the Board of Directors in meeting assembled have unanimously past a resolution in which they express the sincere gratitude of the Company for your brave act. Furthermore, as a more material expression of appreciation they have awarded to you the sum of one thousand dollars, as per enclosed check.

Hoping that you will see fit to accept this slight testimonial of thanks, I am

Yours very sincerely,

ALMER P. THOMPSON,
President, C. W. R. R. Co.

War Department
Washington, D. C.

Sir:

My attention has been called to an act of yours, by virtue of which a whole regiment of troops was saved from possible annihilation from train wreck plotted by enemy aliens. I am furthermore informed by the colonel in command of said regiment that in so doing you displayed a quick-wittedness and ingenuity, the like of which he had never seen before. The details are before me and after a careful perusal of them, I am led to the same opinion.

Now it is the purpose of this department to show in some way its appreciation of the great service which you have done the nation at large by saving the lives of those upon whom it depends to make the world free for democracy. I have information that you are at present employed as telegraph operator, which post ought to make you eligible for enlistment in either the Engineers or preferably the Signal Corps. Now, if you can see your way clear to joining either branch, this department will confer upon you the rank of First Sergeant and later that of Second Lieutenant should you prove your capability in the capacity first mentioned. You may use this letter as authority for such rating when presenting yourself for examination.

Again thanking you in the name of the department for your services and trusting that it may have further use of them in the Signal Corps, I remain

Yours very truly,

N. D. BAKER,
Secretary of War.

James Hanlon, Esq.,
Winslow, Pa.

* * * * *

Did Jimmy join?
Well, would a duck swim?

[THE END]

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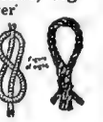

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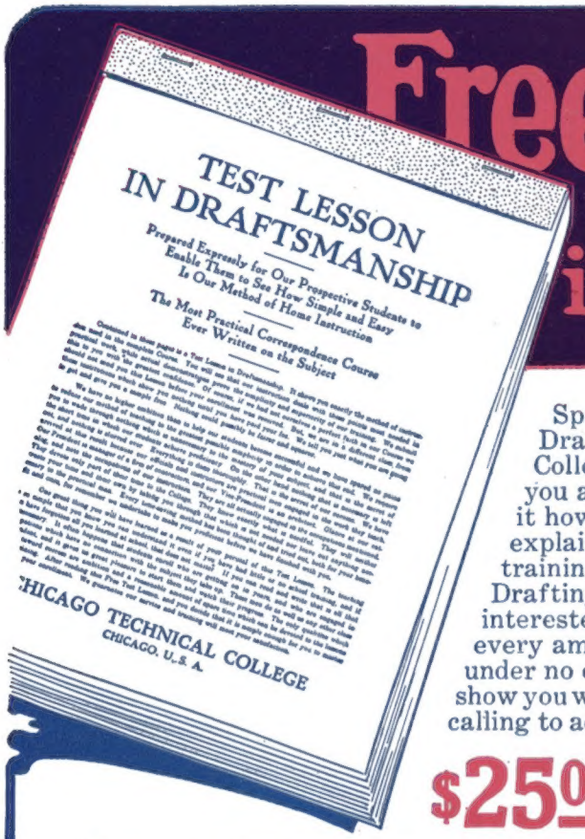
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